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ABSTRACT

This guide describes an introductory course on technology designed for the secondary schools of New Jersey that was developed to provide students with their first formal experience in a technology program. Part 1 provides educators with a broad overview of the course, as well as a detailed description of the course content. The course consists of six instructional modules: an introductory module plus five modules concerned with design/problem solving, the history/evolution of technology, systems of technology, resources of technology, and control technology. Each module provides the teacher with: (1) a brief introduction to the module; (2) the objectives of the module; (3) background information for the teacher; (4) a technology perspective; and (5) teaching strategies for meeting module objectives (including lessons and activities). The appendices include a taxonomy of course content, additional technology activities, an evaluation instrument for technology activities, listings of recommended tools and supplies for an introductory technology course and recommended materials for a technology resource center, and a pre-post technology interest and assessment instrument. (TW)

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THE COMMISSION ON TECHNOLOGY EDUCATION

FOR THE STATE OF NEW JERSEY

NEW JERSEY
TECHNOLOGY EDUCATION CURRICULUM PROJECT

LEVEL 1:

# Introduction To Technology

COURSE

SE 049 745



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The Commission on Technology Education for the State of New Jersey would like to acknowledge the work of the individuals who contributed to the development of this course and, as a result, have helped shape the future of our profession in New Jersey. Participants in the 1986 curriculum development workshop invested their energy and expertise in the success of this effort. The names of these professionals appear below.

The Commission would also like to acknowledge the contributions of other key individuals who provided both their time and experience. William Alexander, Trenton State College; Pat Hutchinson, Drexel University; David Perry, King Alfred' s College, England; and Ronald Todd, New York University, provided valuable input into the philosophical and curriculum development process. In addition, the work of the New York State Education Department and Technology Teacher Training Project were helpful resources to our work.

The detailed material for the six Modules was generated, refined and edited by several of the outstanding technology educators in New Jersey: Frank Cappelle, Ken Howlett, John Pagluica and Michael Wisnovsky. Their efforts have made the production of this curriculum document possible.

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## INTRODUCTION:

The teaching of technology is not new. Some teachers have been doing it, in at least a limited sense, for many years. But over time, the definition of the teaching of technology has evolved just as the technology we are teaching has evolved. Keeping current with the teaching of technology is every bit as important as keeping up with the changes in technology itself.

The teacher of technology does not need to be an expert in all areas of technology. But that individual does need to have an interest and curiosity as well as a conceptual understanding about a wide range of technological fields, devices and issues. When it comes to tackling new lessons or considering student activities, teachers will need to ask themselves "why not?" where before they may have asked "why?" This philosophy will be especially important in the introductory course presented here.

The goals of the Technology Education curriculum as it has been conceived are somewhat different than those for the industrial arts. The learning which should be developed within our students must reflect their world and the world into which they will grow and mature. That world is not static. It is a world of dynamic change and ever increasing complexity.

In introducing the need to study technology, the Commission for Technology Education for the State of New Jersey (1985) wrote:

> Society today is pervaded by a technology that is changing at an ever accelerating pace. The tools which we use on a day-to-day basis were unimaginable only a few years ago. With the help of computers we amass, sort and utilize far more information than we have the time or ability to comprehend. Technological interfaces with the biological world continuously improve our prospects for health, well-being and longevity. We have within our grasp the means to explore environments too large, too small, too alien or too far away for previous consideration. Along with these achievements, the destruction of all we know is also at our fingertips.
>
> Never before have so few of us understood the devices and systems that surround us. Yet we are faced with the responsibility for controlling this awesome power. The degree to which the products and impacts of technology can be controlled in a democracy depends upon how broadly among the population a level of technological understanding can be achieved. It is the mandate of public education to provide that understanding.

These words describe the charge undertaken by the Commission. Through the implementation of a **Three-Year Plan** for the transition to technology education the Commission has facilitated the development of a technology education curriculum, public awareness and teacher in-service training. The production of this **Introduction to Technology** guide is part of that effort.

The Commission's first year report contained nine major goals for technology:

1. To help all students make informed career choices.
2. To help all students make informed decisions as consumers of technology.
3. To develop an understanding of the impacts and consequences of technology so that as citizens they can exercise some control over these developments as well as recognize the need and desirability of technological developments.
4. To apply creative problem solving techniques to the solution of technical problems.

5. To develop an understanding of resources, processes and outputs and their interrelationships within technological systems.

6. To apply the concepts of mathematics, science, social studies, language arts, humanities and the arts in the context of contemporary technology.

7. To engage students from all sectors of society in meaningful first-hand experiences with technology.

8. To use technology as the catalyst for an interdisciplinary approach to education.

9. To develop an attitude that encourages individuals to keep pace with a rapidly changing society and realize that education is a life- long process.

These goals have formed the framework for the development of a model technology education curriculum for New Jersey schools. The **Introduction To Technology** course contained in this guide is designed to provide a student's first formal experience in a technology program. It is anticipated, however, that the **Technology for Children** program will expand and provide technology awareness in the lower grade levels through integrated activities with traditional school subjects.

The introductory course described in this document is appropriate for students in grades 6, 7, 8, 9 or 10. Although activities will need to be modified to suit particular ages, the material content and the general strategies for teaching the course should remain valid for all age groups.

**Introduction To Technology** is called a LEVEL 1 course as it is meant to be the first in a series of technology education courses within a complete curriculum. As courses are developed for LEVEL 2, LEVEL 3 and LEVEL 4, it is the intent of the Commission to develop similar course guides.

## PART I:

# OVERVIEW OF THE INTRODUCTION TO TECHNOLOGY COURSE:

The following section describes the LEVEL 1 course Introduction to Technology. It is meant to provide a broad overview of the course objectives and content. Individual modules within the course and practical teaching materials are included elsewhere in this document.

Looking over the course materials and taxonomic outline it is apparent that there is an overwhelming amount of content for an introductory course. This was done to allow the greatest flexibility of choice for the many different situations in which the **Introduction To Technology** course would be taught. It is probable that no one-year course could actually teach all the concepts or use all the activities. It is suggested that the course instructor take the material provided here and assemble a course which fits the students' age, grade level and background experience, facilities and supplies available, duration of the course and her/his own expertise and interests.

With a full academic year course all six modules could be covered to some degree and emphasis placed on one or more modules for some in-depth work. Courses running for less than the full year should begin with Module 1 (Introduction) and provide a solid general background of terminology and concepts. Module 2, "Design/Problem Solving", provides a sound foundation for students to tackle activities throughout the course and in subsequent experiences in technology and should also be included in all variations of the course. The remaining modules may be included and/or emphasized as time and other influencing factors permit.

The modules devoted to "History/Evolution", "Resources" and "Control" offer exciting opportunities for students to do activities ranging from very simple to highly complex. The module on "Systems" provides a valuable tool to study the impacts and consequences of technology on the individual and society and help us all to speculate on the future directions technology will take us during the lifetime of our students. Figure 1 shows some variations possible with full and part-year courses emphasizing different modules. Other configurations are possible.

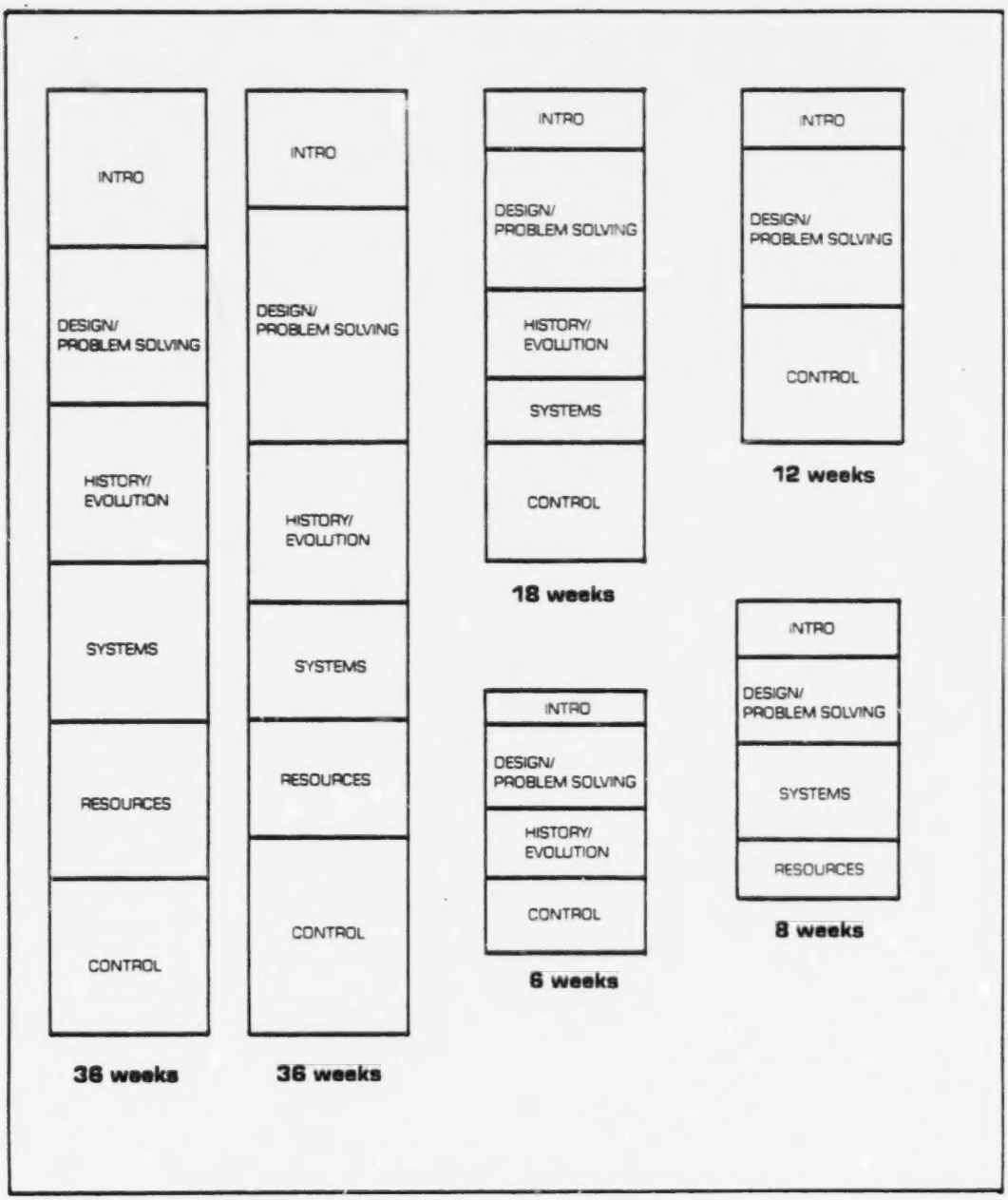
The modules are developed to provide a structure around which to build the course. Because all modules deal with an aspect of technology, there is overlap in the objectives, concepts and activities used throughout. The student will encounter "resources" when studying Module 4 (Systems), and again when Module 5 (Resources) is taught. In fact, the student should encounter the concept of resources throughout the course because it is an important concept necessary to the understanding of technology.

The point is, the teacher may wish to combine some modules, such as Systems and Resources, and in doing so, will not adversely effect the success of the course experience. Many activities appropriate to one module will also be appropriate and usable in others.

The material provided within this document will give the teacher the raw material with which to custom build an Introduction to Technology course for the time period available. By choosing course content and activities which relate to the course objectives which follow, a well balanced course can be constructed that will provide students with the experiences which will make them more aware of the role of technology in our world today and more intelligent citizens tomorrow. Appendix E contains a planning worksheet which should facilitate the planning of an Introduction to Technology course.

The vast amount of teachable material in this document can also be used to develop advanced courses in technology. Each module could be expanded into a course by itself. The Design/Problem Solving module could be expanded to an excellent Research and Development course, allowing students to gain in-depth experiences in their own interest areas as well as develop graphic communication skills. The History/Evolution module could be expanded to include greater depth in the evolution of specific technologies and provide an opportunity to take advantage of the science and technology museums, historic villages and other New Jersey historical institutions within reach of most schools in the state. The Resources and Control Technology modules offer a unique opportunity to develop truly innovative courses in the study of technology.

**Note:** In addition to the lessons and activities suggested in the six modules, it will be necessary during the course for the teacher to develop lessons and demonstrations on using certain tools, materials and processes. These concepts and skills should be introduced as students have a "need to know" as opposed to giving a comprehensive lesson/demonstration early in the course.




**Possible Variations of Module Emphasis in Introduction To Technology Course**

**Figure 1**

## Course Title: INTRODUCTION TO TECHNOLOGY

### Course Description:

As a Level 1 course, Introduction To Technology will emphasize design/problem solving processes, the evolution of technology and the systems approach to understanding technology. The areas of information, physical and biological technologies will be explored through the application of design/problem solving activites which engage students in first-hand experiences with technology. This course will acquaint the student with the impacts of technology on the individual and society, as well as related careers. Thematic approaches are appropriate at this level.

**Course Duration:** Adaptable from 6 weeks to 38 weeks

### Course Goals:

1. To develop a technological vocabulary and display a working knowledge of technological terms.
2. To employ a wide range of communication skills including writing, recording, drawing, modeling, and speaking.
3. To demonstrate an understanding of the steps involved in problem solving.
4. To apply creative problem-solving skills through the design process and modeling techniques.
5. To employ various techniques to document progress during the design/problem-solving process.
6. To be able to make objective decisions through comparative analysis.
7. To identify some of the positive and negative impacts of technology on society, the individual and the environment.
8. To trace the major events in the history/evolution of technology.
9. To develop an understanding of the elements of a technological system including the necessary resources, processes employed and the possible outputs resulting from the system.
10. To develop an understanding of the basic elements of Physical, Information and Biological technologies.
11. To describe the resources of technology including energy, tools/machines, materials, humans, information, capital and time.
12. To develop an understanding of control as it relates to all technologies
13. To understand the importance of keeping pace with technology.
14. To promote an appreciation of the necessity of continual learning as a member of a technological society.
15. To develop an awareness of Technology-related careers.
16. To demonstrate acceptable standards of safety within a laboratory environment.

## Course Outline:

### Module 1: Introduction to Technology

The first module has the same title as that of the course. It is intended to acquaint the student with technology through very broad experiences. Technology is introduced by exciting and meaningful activities which capture the imagination and interest of students. Activities in this module are short and involve minimal skill development. This module attempts to capture the enthusiasm and interest of students rather than develop any degree of technical proficiency.

### Module 2: Design/Problem Solving in Technology

The design/problem solving module focuses on the basic concepts, cognitive skills and process of solving technological problems. Emphasis is placed on students' learning the process of problem solving rather than the artifact produced as a result of the process. Most activities in this module are fairly constrained and allow the student to move through the design process as a series of steps. Following modules utilize the problem solving skills developed in module two and take a more flexible approach to the design process. The elements of design are stressed through a series of activities which allow the student to apply what is learned.

### Module 3: History/Evolution of Technology

The history/evolution module is intended to provide the student with a perspective view of how technology has evolved; the impact of technology on early artifacts as well as possible future directions; and the influence of technology on humans, their culture, values and quality of life. Activities in this module may involve the design and fabrication of devices using period tools and technology, the construction of operational models of period tools and machines and/or activities centered around a futuristic theme.

### Module 4: Systems of Technology

The systems module is intended as an introduction to the systems model of technology. The systems model is a construct for helping students understand technology by analyzing inputs, resources, processes and outputs. When processed through technological systems, information, energy and materials are altered. Activities in this module may involve the development and construction of simple systems as well as the analysis of natural and technological systems in the world around us.

### Module 5: Resources of Technology

The resources module is intended to acquaint the student with the resources of energy, information, materials, tools/machines, capital, humans and time which are necessary for technology to take place. These resources are the inputs to the processes employed in any technological development. Activities in this module include first hand experiences with one or more of these resources to provide the student with insight into the difficulty of resource choice and its effect on the system process and outputs. The students learn to appreciate questions related to "possible", "feasible" and "desirable" resources.

## Module 6: Control Technology

The control technology module is intended to acquaint the student with the basic "building blocks" of modern technology. Emphasis is placed on understanding mechanisms, and mechanical and electronic control. Activities include simple problem solving in the design and fabrication of model mechanical devices using gears, cams and levers and the electrical control of mechanical devices. Opportunities for introducing simple computer sensing and control make this module a relevant and exciting experience.

PART II: COURSE MODULES

# MODULE 1: INTRODUCTION TO TECHNOLOGY

The first module is intended to accomplish several goals. First, to orient the student to the kinds of activities and learning which will take place for the duration of the course and to give a sense of what will be expected of the student in turn. But perhaps more importantly, the introduction module should excite and motivate the student to want to learn about technology and provide experiences which will show the relevancy of this endeavor. Activities, discussions, assignments and readings should reflect these aims. Finding topics of interest to students may be more important at this stage, than most other considerations.

The use of materials, processes and tools should be limited to those requiring little training and skill. The use of paper, card, soft wood in square dowel form, clay, and easily worked acrylic plastics will allow the student to use a hands-on approach to solving problems but will not require the teacher to devote large blocks of time to skill development and safety. Of course even simple tools such as scissors, xacto knives and glue guns demand careful instruction and safe working practices.

## I.1 Module Objectives

1. To excite and motivate students to want to learn about technology.
2. To introduce students to Design/Problem Solving through several activities.
3. To provide students with a perspective view of technology as the extension of human capabilities and a means of satisfying needs.
4. To introduce the concepts of physical, informational and biologically-related technologies.
5. To introduce basic concepts of structures and mechanisms as building blocks of physical technologies.
6. To introduce important terms and their definition.

## I.2 Background for the Teacher

Technology is not a new concept but one which many of us take for granted. Pick up a phone, turn up the thermostat, start a car, and the thought is not of the technology involved but the need technology meets. What is technology? Where did it come from? What do we do with it? How do we apply it? These are some of the questions addressed in Module 1.

A number of definitions of technology are helpful in discussing this subject with students. Depending upon the age, grade level and experience of students in the course, some of these definitions may be too complex and cause confusion. The definitions follow:

Technology- the knowledge and study of human endeavors in creating and using tools, techniques, resources and systems to manage the man-made (sic) and natural environment for the purpose of extending human potential and the relationship of these to individuals, society and the civilization process (Snyder & Hales, 1973).

Technology- man's (sic) efforts to satisfy his material wants by working on physical objects (Suskind, 1981).

Technology- the application of knowledge and the knowledge of application (Todd)

Technology- the great growling engine of change (Toffler).

Technology- a disciplined process that uses scientific, material and human resources to achieve human purposes.

Technology- the application of knowledge to satisfy needs and wants and extend human capabilities.

Other concepts which should be defined during this module include: evolution, system, resources, control, impacts and consequences, structures, triangulation, compression, tension, shear, mechanisms, culture, values, physical technologies (including transportation, production, construction), information technologies, and biological technologies (including agriculture, aquaculture, medicine and health technologies, genetics), communication, and others.

## Technology Perspective:

We now live in a technological culture. Technology, or the accumulation of knowledge about materials and things of our human-made environment and how to use this knowledge, is a dominant force in our civilization. Technology is a generic term dealing with the ability to control matter, information and energy and includes knowledge and processes in the fields of applied science and mathematics, the arts, engineering, agriculture, medicine, industry and other related fields.

The world we live in today has come about because of the pervading influence technology has had on human institutions, culture, values and beliefs. Technology shapes these elements but institutions, culture, values and beliefs also shape technology. It is important for students to become aware of the powerful pressure technology exerts as well as the pressures our institutions, culture, values and beliefs exert in the shaping of technology.

During this first module, students should be introduced to technology in a positive, exciting atmosphere. Emphasis should be placed on developing broad concepts and exploring technology through "hands-on" experiences.

## I.3 Strategies for Meeting Module Objectives:

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**Objective 1.** Excite and motivate students to want to learn about technology

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Lesson or Activity

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1a Lesson: "A Glimpse of the Course" 20 minutes
Overview of the course, some to the areas to be studied. Discussion relating to What is Technology? How did it begin? Where is it Going? (What will your life be like in, 30 years?)
Student Activity - 20 min. "Using 4 sheets of letter size paper and 18" of transparent tape, build the tallest tower possible." Students should work in groups of 2. Scissors are permitted. (Activity M 1.1) After activity discuss solutions, point out "best" solutions. Relate this simple solving of the problem you have given class to more complex problems of shelter, transportation, communication, etc.

1b Lesson: "The Technology Trap" 20 minutes
During discussion ask students to describe their everyday lives if tomorrow we had no gasoline (or other important resource). Through discussion bring out the time during the early part of this century when we became dependent on gasoline (or the resource you have chosen).

1c Show a segment of video, "Connections: The Trigger Effect" (#1) which addresses the electrical " blackout" of New York City and the impacts of that incident.

1d Activity: Linear Measurement Concept (Appendix B, M 1.4)

1e Lesson: "Tools: What Are They And How Do You Use Them?" 20 minutes
Show xacto knives, small saws, white glue and glue gun. Discuss safety and use of these tools and supplies. Have students describe what human senses and abilities these tools extend. Have students construct a cube structure from square wood dowels using saw, white glue or glue gun. Aim for accuracy in cube where all members are 90 degrees apart (6" on a side). When dry, test cubes by student standing on top.

1f Activity: Helping Hand (M 1.5) or other activity from Appendix B.

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**Objective 2.** Introduce students to design/problem solving

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Lesson or Activity

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2a Lesson: "Bringing About Technology" 10 minutes
Present simple 4-step problem solving model: define problem; generate solutions; choose a solution; build solution
Student Activity - 35 min. "Design and build a bridge to span one yard (or meter) which can hold 20 pounds suspended from the center." Students are given 10 1/4" X 1/4" square dowels 12" long and index card stock which can only be used as 1" glued gussets (Appendix B: M 1.2). Test solutions and discuss the results. Begin to point out principles of triangulation. Evaluate results per M 1.2.

2b Activity: Hill Climber (M 1.7) Have students follow 4-step design process and develop a hill climb vehicle. Students should generate three ideasbefore they begin to build. Reasons should be listed for best choice. Make an event of the final test of solutions (take pictures, video record, etc.)

2c Activity: Let students choose among at least three problems such as M 1.8, M 1.9 and M 1.10 or others. Make clear that final assessment of project is how closely they follow the process of design and how well the solution they choose solves the problem.

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**Objective 3.** Provide students with a perspective view of technology as the extension of human capability

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Lesson or Activity

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3a Show "Connections" series #2 through #10 as deemed appropriate during the course. Short (10-20 minutes) segments from each installment may be set-up ahead of time and a particular point can be reinforced.

3b Other films and videos in Appendix A can also be used will equal success. Be sure to preview all material.

3c Activities: Bottle Cap Remover (M 1.9) Show how this device will be designed as an extension of our ability to grasp something; how tools perform this function.

3d Lesson: "How to Sketch Your Ideas" 40 minutes with practice activity. Elements of sketching; sketching lines, curves, circles, etc. Looking at what you are drawing; visualizing; adding a bit of color to emphasize. NOTE: Make the point that all activities from now on will require sketches of several solutions before construction begins.

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**Objective 4.** Introduce concepts of physical, informational and biologically-related technologies

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Lesson or Activity

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4a Lesson: "The Areas of Technology" 15 minutes Explain how all technologies fall into one of the categories of physical, information and biologically-related technologies. Give a number of examples and draw additional examples from students. Incorporate career prospects in each area. Use Space Careers book in Appendix E for ideas about future jobs.

4b Plan an activity around communication. Discuss encoding, transmitting, receiving, decoding; compare language with morse code and how there has to be some prior agreement as to what the word "trouble" means and what "SOS" means and what ...---... means. Have students develop a way of transmitting and receiving morse code; have a message sent from one group to another.

4c Discuss writing, talking, drawing, sketching and modeling as communication of technical ideas;

4d Show segment of "The Day The Universe Changed", episode on invention of the printing press.

**Objective 5.** Introduce concepts of structures and mechanisms

Lesson or Activity

5a Activity 2a above

5b Activities M 1.2, M 1.3 in Appendix B.

5c Lesson: "Holding Things Up" 20 minutes
Discuss the concepts of compression and tension forces; show what will happen to paper, thin metal, etc. when under compression and tension; see if students can come up with ways of shaping these materials to help resist compression forces; look around lab and point out examples of shapes which resist compression forces: table and chair legs, etc.

5d Activity: Using paper straws and hot glue gun, replicate the structure of a high-tension electric tower to scale. Introduce the concept of scale: provide many examples: house plans; model aircraft and cars; etc.

**Objective 6.** Introduce important terms and their definitions

Lesson or Activity

6a Lesson: "What is Technology?" 40 minutes
Get students involved in a discussion of the meaning of technology; can we touch it? taste it? see it? Use definitions and write them on the chalk board or overhead. Examine differences. Use definitions given here.

6b Have some "high tech" examples on hand such as CD player, computer, robot, etc. and ask if these are technology or the result of technology? Terms to be introduced: technology, technologies, (medical technology) physical, information and bio-technologies as categories. Use chalk board to write large categories and sub-sets for clarification. Get students to give examples and write these in appropriate category.

6c Show remainder of "Connections: The Trigger Effect", if available. Discuss the role of technology in shaping our world.

Begin a series of short activities from Appendix B to reinforce content above. Emphasize:

technology as a means of satisfying human needs and extension of human abilities

problem solving: generate at least 3 ideas beforebeginning construction

sketching: sketch ideas for above and work out chosen solution before construction

communication: in addition to sketching, communication skills such as reading, writing, speaking

terminology: encourage students to use correct terms for concepts and processes

technology areas: areas of physical, informational and biological technologies work habits: safe and correct work habits when using tools and materials

# MODULE 2: DESIGN / PROBLEM SOLVING

The module on design/problem solving looks at both the problem solving process and the elements of design. The study of the problem solving process will provide students with a way of approaching technological problems which is useful to most activities in this course and in further experiences with technology. Using this process students will experience the steps used in industry and other technologies to satisfy needs and find solutions. Through the application of this process, the student will have the opportunity to play a variety of roles and sample a number of different career fields. The design process is also transferrable to other areas of students' lives.

The elements of design are covered to develop communication skills useful throughout this course and subsequent technology courses. The skills of writing and speaking are also emphasized as an important part of the communication process.

The New Jersey MIIT (Mini Inventions and Innovation Team) program is an ideal focus for design/ problem solving activities. It can provide the teacher with instructional materials and its annual conference (usually in May) is an exciting, culminating experience for students.

## II.1 Module Objectives

1. To acquaint the student with the problem solving model.
2. To provide the student with practical experience using the design/problem solving process on technological problems.
3. To develop basic design and communication skills.
4. To develop the ability to document each step of the design/problem solving process with notations, drawings, photos, etc.
5. To develop an attitude of willingness to express and try new ideas.
6. To integrate MIIT (Mini Inventions Innovation Team) activities into the curriculum.

## II.2 Background for the Teacher

### Problem Solving Process:

The problem solving process is critical to a successful technology education program. In this process there is a series of sequential but not rigid steps through which the student moves. The outcome is not only a project and a deeper understanding of the process of technology, but also an experience in independent thinking and an opportunity to incorporate individual interests with generalizable skills. The students are learning how to learn.

## Problem Defining:

If a general definition of technology is "the application of knowledge to satisfy needs and wants and extend human capabilities" then the design process is about how technology achieves these ends. Central to this process is the identification of a problem in need of a solution. On the surface this appears to be a simple task but is, perhaps, the most important and demanding step. For example, the idea of constructing a better wheelchair. The wheelchair itself is not the problem--it is a solution. Designing a wheelchair is a step toward a solution and implies a whole range of decisions already reached. As a first step then, let us back up to the real problem situation.

Some people, through injury, illness or birth defect cannot adequately function in a world built for mobile people. Defined in these terms, the problem takes on a new meaning and solution possibilities. A wheeled device is only one of many possible alternatives where electrical stimulation of muscles and braced walking attachments for limbs are proving successful. Because of constraints under which the student will work the optimum solution might well be a wheeled device but is important to have the student reach this point on her/his own. Backing up to the real problem opens up creative possibilities and divergent thinking and allows the student to see the whole process in context. Not incidentally, choosing to focus student work toward human related problems (such as devices for the disabled) can also have a positive effect by "humanizing" a program which too easily can fall into a cold, mechanistic image. Students not intrinsically fascinated with technical devices and machines may be attracted to such a program when the beneficial side of technology is emphasized.

## Problem Specification:

The second step in the process is one of specification. If the problem is centered around a mobility device for the disabled, will it be self-powered or motorized? Will it fold-up? Is it intended for an adult or child? Or both? The specifications provide some expectations and limitations for the project and can be referred to at a later date to see if the solutions generated are addressing the important aspects of the intended problem. The specifications take the form of the "design brief" which then guides further development. In earlier experiences the design brief may be used as a starting point and given to the class as a group or individual activity.

## Design Brief:

> DESIGN AND BUILD A VEHICLE WHICH WILL TRAVEL THE MAXIMUM DISTANCE POSSIBLE WHEN RELEASED AT THE TOP OF A 6 FOOT LONG RAMP INCLINED AT 15 DEGREES FROM THE HORIZONTAL. THE VEHICLE MUST TRAVEL BY ITS OWN MOMENTUM.

The brief above describes what the vehicle should be able to do. It does not, however, specify what materials may be used so that the student would be correct in assuming that ANY materials or parts purchased, found, borrowed, etc. may be used. If you wished to limit this aspect you would place a specification in the brief such as "...using the materials provided" or "using materials found in the lab or around your home" (a good idea since LP records make excellent wheels with low rolling resistance).

Next, the technologist (student) must gather information about the problem in order to best solve it. If the project involves human end-use, ergonomics should play an important role. In the case of the problem mentioned earlier involving mobility devices for the disabled (certainly an advanced problem and not appropriate for an introductory course), interviews with individuals who might use such devices will prove enormously valuable to the designer/ builder. In addition, there are size limitations suggested by various national organizations and government agencies which represent the less able, and the student should become familiar with this information early in the project. Other data should be gathered about materials, standardized parts, finishes, and so on.

In the case of our vehicle above, investigation may need to take a slightly different turn. Without national organizations governing vehicles of this type, information about materials, sizes, weight, rolling resistance, etc., may need to be found through experimentation, application of knowledge given by the teacher in some short lessons on elementary physics of inertia, etc. As projects become more complex or more closely related to the "real world", the reliance on this step of information gathering becomes evident. For example, if a junior high class decided to design and produce a device to help elderly people remove the tops from bottles or jars, then the investigation stage takes on a critical importance. Determining just what kinds of bottles and jars provide difficulty; why do elderly people have problems in the first place?; how much force can be comfortably exerted; what materials will hold up to the use?; what is the most cost-effective material to use?; and probably many more. Information gathering should emphasize the search for and further development of existing solutions to the problem. Except in historical re-enactment, solutions to problems should build on the best of other peoples' efforts rather than "re-inventing the wheel" through ignorance. This standard communicates an important message about the way people best address everyday problems.

A log should be kept by the student which includes notes and ideas about the problem, summaries of information gathered, questions asked about the problem and, at this point, sketches and drawings of the alternative solution designs. Later inclusions could be photos and evaluation of the final project construction and testing. If students can be encouraged to keep a log of this documentation from the very first design/problem solving experience on, then the process and documentation becomes a natural part of project work in the technology program (see Appendix C for more information about documenting technology activities).

## Idea Generation:

The generation of ideas for solutions is sometimes referred to as *brainstorming.* That term, however, is correctly applied to a specific idea-generating technique which has the following tenets:

1. the more ideas generated, the better the odds of a quality idea emerging;

2. group oral ideation is more valuable than individual ideation because group members stimulate one another;

3. a non-threatening atmosphere is necessary for free expression of ideas; therefore, criticism is deferred;

4. a constrained time frame enhances the creative atmosphere.

Group brainstorming is both effective and fun, but ideation can also be stimulated and maximized in individuals by using techniques such as sketching/doodling, attribute listing, forced connection and synectics.

## Choice Making:

In virtually all ideation, deferred criticism allows the imagination free reign. Recording of emerging ideas is critical for allowing revisiting of earlier inspirations.

Choosing the best among a number of ideas is less straightforword than it may appear. Two strategies for choice- making, transferrable to outside situations, are listing of attributes of the ideas and comparing them; and development of a matrix, one axis of which lists specifications generated for the design brief, with the list of ideas forming the other axis. Checking off requirements and constraints met and scoring each idea is a way of organizing the data to evaluate ideas.

After choosing the solution most appropriate to the specifications, the student proceeds to the construction stage. However, there may be a number of sub-problems which need solutions (the case with most technological problems) so modeling, experimentation with different materials, fastening techniques, shapes and sizes, may need to be done before actual construction of the final design is undertaken. A model may be constructed which will serve to overcome problems in the finished product or to try out specific ideas. This may drag out the project but more often it saves time. The saying "There is never enough time to do the job right but there is always time to do it over." applies well here.

When the project construction is completed the testing and evaluation of the project begins. This may be as simple as applying the specifications to the end product to see if it does all the things that it was supposed to do. But more often it is performance testing as in the case of a practical device. In the case of the momentum vehicle, placing it at the top of the ramp, letting it go and recording the distance traveled would constitute the testing process. The jar lid removers would go to a few elderly people for their reactions and evaluations. This phase is important to the design process and ties the experience together for the student. The "real world" connection is motivating, relevant and demonstrates the true essence of technology as a force in society and our personal lives. It is recommended that the tests be stated at the beginning, during the problem identification/specification stages.

During testing and evaluation the student is able to determine if the finished project meets the original requirements set forth earlier. If the project fails under testing the student does not need the teacher to point out that something is wrong. Likewise, successful projects are evident from performance or how well they meet the design brief specifications originally set up for the problem.

In summary, the technology design process is problem identification, specification, research and information gathering, generating alternative solutions, choosing the optimum solution, construction of the project or models, testing and evaluation and finally, adjustment where appropriate. The description set forth here has been, perhaps, oversimplified but the essence of the process is intact. There are variations of this approach which appear to seek essentially the same results. Students should be strongly encouraged to carefully document each step with drawings, photos and written naratives. Both project and the documentation are integral to the process and cannot be separated. It has been observed that students who employ the design process are more likely to feel "ownership" of their project than is evident in cases where they are given "cook book" activities or directed to construct a project from teacher generated plans.

## Evaluation of Student Work:

The evaluation of a student's progress and the assignment of a final grade is difficult in the best of programs. In craft or trade oriented curricula the apprentice is taught the correct procedure for the particular task and when the quality of work is acceptable to the journeyman or master the next procedure is shown. The journeyman's craft is recorded in the form of various tasks, referred to as a "task analysis." When the apprentice can perform all the tasks to the satisfaction of the journeyman or master the pupil has completed the formal training of the apprenticeship.

In technology education evaluation becomes more difficult. Because one of the major goals of technology education programs is the development of the ability to use the design/problem solving process to generate creative solutions to technical problems, the assessment of students cannot be limited to judging finished projects or the memorization of facts. Allowance must be made for assessing the students' use of the processes and the ability of the student to apply the process to new situations. This is referred to as transferability of learning.

Assessing student work through the use of the evaluation instrument in Appendix C will allow both student and teacher to keep track of the student's strengths and needs as problems are solved. The evaluation criteria are clear and students should receive a copy when the design/problem solving process is introduced. The assessment weighs both the process and the product.

For more information and a further explanation of the evaluation process see the Commission publication: "Teachers' Manual for Technology Education". A model of the design/ problem solving process is presented there along with suggestions for documenting each step for later evaluation. Although the material in that publication is quite a bit more detailed than normally necessary for introductory experiences such as those found in the Introduction To Technology course, it is provided to give the instructor a stronger background applicable to many teaching situations.

## Design Principles:

Design has to do with the arrangement of physical characteristics of a thing, regardless of the purpose that thing is intended to serve. The term designing, therefore, can be applied to endeavors as different as developing a commercial product, writing a novel or symphony, laying out a highway system or generating a curriculum. The terminology basic to designing comes from its graphic aspect, because graphic communication is useful in virtually all kinds of designing, no matter what form the "product" takes.

Elements of design are arranged in relationship to one another in order to achieve conformity to a number of design principles. The principles form the standard by which all kinds of designing can be measured, and include:

function - it works
aesthetics - it's pleasing to the senses
structure - it's reliably put together
economy - it achieves the most with the least
integrity - it reflects the ethical considerations of designer and user

An elegant design is one which achieves all these objectives and does so in an original way. Six elements of design include:

line
shape
form
value
color
texture

All these terms undoubtedly have meaning to you, but for design purposes, it is important to distinguish shape as a two-dimensional referent and form as three dimensional. Value is taken here to mean the range from light to dark. All these terms are useful, if not always perfectly distinct- line is an aspect of shape; shape is what you see of a form from any one angle; you can vary the value of a line or color; and texture, magnified, is a collection of forms.

Line seems to be in its "purest" form when applied to paper for drawing or writing. But 3-D uses of line are apparent in everything from fishing nets to steel cables in suspension bridges. Line is a common way of decorating surfaces- notice the linear ridges or indentations applied to computers, radios, calculators, not to mention the stripes on your sweatsocks. Line is also such a strong aspect of the contour of something, that it sometimes draws more attention than the whole shape of the object (e.g. "love the lines of that Porsche" and "the lines of that suit are really classy"). These are all still graphic references, but the terms "story line" in writing, "line of reasoning" in mathematical or scientific problem solving, "melodic line" in music and "product line" in marketing are really referring to the same concept- a connected strand with direction, length, weight, character, etc.

**Shape**, what you get when a line closes back on itself, is also a transferrable concept in the creative world. From the "pear-shaped tones" of the vocalist to the fact that the curriculum is "shaping up", we are referring to the recognizable two-dimensional aspect of the thing. Graphically, we refer to organic shapes (which seem random, meandering or "natural") and rectilinear shapes (which have straight sides meeting at corners and look human-made). Shapes can have hard or soft edges, be light or dark, opaque or transparent, colored or textured - and can by these very characteristics, communicate all kinds of messages: "That is one space-age looking toaster, not at all like the 1930's version I inherited from my grandmother."

**Form** is the three dimensional counterpart of shape: physical objects have this quality, and either they or we have to move in space and time to appreciate it. The same characteristics apply to form as to shape, but much of the functioning of products depends on form. The overall size, weight, materials and purpose constrain the form of a car, building, sculpture. If you have an idea to share, should it take the "form" of an article, a monograph, a report or a novel?

**Value** is, in graphic terms, white, black and everything in between. It can be more generally applied to the extremes, and the steps between them, of anything. Value always indicates things that are relative; value is seen in contrast to something else. Visually, a light or "high value" shirt makes a dark or "low value" tie more visible. Discussion of a "heavy meal" versus a "light lunch" is also a value discussion, although the term is really not used in that situation. "Value judgement", indicating the judged worth of a design, is not, however, what this use of the word "value" is about.

**Color** is possibly the most accessible graphic design element. We react to it on emotional levels and it directly affects our impressions. "Her obsession with craftsmanship colors everything she does." Color and emotion are clearly linked, thus the phrases: "green with envy" and "feeling blue". Designers of objects have a powerful tool in this element; playwrites use and travel agents advertize "local color" to lend authenticity and pizazz to their products. Physically, color has several dimensions, including wavelength, value, intensity, all of which can be manipulated by the designer.

**Texture** is useful for functional and aesthetic purposes. As an alternative to value and color, which make surfaces interesting, texture is applied to objects which might be touched or at least might take advantage of lights and shadow. Rough textures on tool handles, diving boards and skateboards provide needed friction for grip. In doctors' offices, where color contrast is played down to soothe patients, contrasting textures (carpets, plastic, wood, glass, chrome) are often employed to make the surroundings interesting.

The relationships among the elements describe how those elements are arranged to achieve the designer's ends. As the cabinet maker may choose from a number of different approaches to joining the sides of a box, the designer can put his/her "pieces" together in a variety of ways. Design relationships are described by concepts such as:

**balance**
**emphasis / accent**
**pattern**
**rhythm**
**space**
**proportion**
**scale**
**contrast**
**harmony**
**enframement**

These and parallel concepts are applicable in architecture, music, creative teaching and product design. Familiarity with the design elements and sensitivity to possible relationships make technological designing a reliable process, accessible to anyone willing to pursue an idea.

## II.3 Strategies for Meeting Module Objectives:

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**Objective 1.** Acquaint students with design/problem solving model

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Lesson or Activity

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1a Lesson: "Designing Technology" 20 minutes
Technology does not usually come about by accident-- it is planned. The process used to satisfy our needs and wants, (develop products, processes and schemes) is called designing. Introduce the linear model of design/problem solving.

1b Activity: Inertia Vehicle (M 2.1)
Make sure students develop at least 3 solutions before constructing a chosen solution.

1c Lesson: "Problems All Around Us" 20 minutes
Where problems come from. How to identify problems. Problems which arise from physiological, social and psychological needs.

1d Looking for Problems: Take students to school cafeteria with an assignment to take notes about any technological problem they can find. (Hints: Are coats lying about during lunch? Is there a lot of noise during the lunch hours? Is mud tracked in when it rains?) Allow enough time at the end to discuss the problems found. Take some of the problems and develop briefs.

1e Lesson: "Information Gathering" 20 minutes
Sources of information including books, magazines, interviews, on-line databases, etc. How to find out answers to questions.

1f Assignment: Each student must find out the following information for a country (assign a different country to each student): population at last census; capitol; typical type of residential homes and materials used to build; a drawing of a typical house done by the student (example: Switzerland, chalet, wood). Assignment could also be done with a particular year and make of car: How many were made? What size engines were available? What horsepower options were available? What models were available? Other similar ideas will work just as well. Try to find something of interest to the students (Skateboards?) The idea is to get them to look something up in the library or other resources. When assignment is turned in, discuss the sources used by students to find information.

1g Lesson: "Coming Up With Solutions" 20 minutes
How to generate alternative solutions through brainstorming; divergent thinking skills.

1h Activity: Brainstorming session- following the rules of brainstorming, have class come up with as many routes of travel as possible (in 5 minutes) for someone who wanted to go from the school to the local mall (or where ever). Have a county map on hand and look at the routes after the session is over. Discuss that during brainstorming you do not evaluate and even very long, round about routes are okay. Next, following the same rules of brainstorming, come up with solutions to the problem situation: "books are heavy and difficult to carry to school when you have a lot" (or come up with your own problem situation). Teacher should throw in things like "mail your books to school and pick them up in the office when you get there" to show that "anything goes in brainstorming".

1i Lesson: "Choosing A Solution" 20 minutes
Optimizing decisions based on safety, economics, legal and ethical considerations, etc. Introduction to cost-benefit analysis.

**Objective 2.** Provide practical experiences with problem solving

Lesson or Activity

2a Lesson: "Modeling A Solution" 20 minutes
Drawing and 2-dimensional modeling; 3-dimensional modeling. Show examples.

2b Activity: Use blocks of 1/2" homosote about 16" X 24" as modeling tablets: Have students develop 2-dimensional working models of mechanisms on homosote. They will need a stiff card material or matboard, push-pins, brasspaper tabs (for pivoting joints), scissors, and tape. Model: three classes of levers; rack and pinion gears; parallel arms (such as used in robots or cranes); crankshafts and pistons; others.

2c Lesson: "Testing A Solution" 15 minutes
Evaluating what you have done against what you said you would do. Did the chosen solution answer the problem? Did it create other unforeseen problems?

2d Activity: Tightly constained problem. Choose from Appendix B or form your own.

2e Lesson: "Improving A Solution" 20 minutes
Redesigning and improving a design solution. How could it be made cheaper? stronger? simpler? able to better satisfy the requirements of the problem?

2f Lesson: "Problem Solving: Going around in Circles " 10 minutes
Introduce the circular model of design/problem solving.

**Objective 3.** Develop basic design and communication skills

Lesson or Activity

3a Lesson: "Principles of Design" 30 minutes
Introduce the principles of balance, emphasis, pattern, rhythm, space, proportion, scale, contrast and harmony.

3b Activity: Use sequence of activities M 2.3 to provide practice in recognizing and using the design principles (Appendix B).

**Objective 4.** Develop the ability to document each step of the design process

Lesson or Activity

4a Lesson: "Keeping A Notebook" 10 minutes
The kinds of things which should go into students' notebooks including sketches, drawings, photos, magazine cutouts, technical illustrations, etc. Emphasize neatness and good-looking presentation of ideas.

4b Lesson: "Suggestions for Documenting" 35 minutes
Hints on how to document. Examples of good practice. How to take close-up photos, etc. How to set up and photograph a product using backdrop, lighting, etc.

4c Require all activities from this point on to be documented in students' notebooks according to suggestions above.

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**Objective 5.** Develop an attitude of willingness to try new ideas

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Lesson or Activity

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5a Activity: Fast Food Box (Appendix B, M 2.4)

5b Activity: Major problem solving activity- pick from list in Appendix B or better, think up your own. Should be tightly constrained.

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**Objective 6.** Integrate MIIT into the curriculum

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Lesson or Activity

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6a Lesson: "MIIT: You Are The Inventor!" 25 minutes
Discuss the NJ MIIT contest; talk about famous inventors and some possible focus for invention ideas.

6b Field Trips:

Edison National Historic Site
Main Street and Lakeside Avenue
West Orange, NJ
(201) 736-0550 (closed Mondays and Tuesdays)

Allaire State Park (revolutionary bog iron community)
Off Route 547 on Atlantic Avenue
Farmingdale, NJ
(201) 938-2371

Newark Museum (exhibits of art, science and industry)
43-49 Washington Street
Newark, NJ
(201) 733-6600

Waterloo Village (18th century village, colonial crafts)
Route 206
Byram/Stanhope
(201) 347-0900

Sci-Tech Center (opening 1990)
Liberty State Park
Hoboken, NJ
World class science and technology educational and exhibit center; watch for traveling exhibits; plan trip to site during construction

6c Invention Assignment: See Appendix B

6d Discuss New Jersey inventions and innovations:
First Celluloid - invented by John Wesley Hyatt, Newark, 1870
First Flexible Photographic Film - Hannibal Goodwin, Newark
First Carbon Telephone Transmitter - T. A. Edison in Menlo Park in 1876
First Phonograph-T. A. Edison in Menlo Park in 1877
First Submarine-John Holland, Passaic County in 1878
First Synthetic Vitamin B-1 - Robert Williams, Roselle in 1934
First Motion Picture - T. A. Edison at West Orange in 1889
First Incandescent Lamp - T. A. Edison at Menlo Park in 1879
First Transistor - three man team at Murray Hill in 1947
First Log Cabin in what was to be the U. S.-Gibbstown, Gloucester County in circa 1640
First Brewery in America - Hoboken in 1642
First Cut Nails in the U. S.- manufactured in Medford
First Steam Locomotive to pull train on track - built by John Stevens of Hoboken in 1824
First Board Walk in the World - Atlantic City in 1870
First Colt Revolver - developed in Patterson in 1836

6e Lesson "Inventors" 20 minutes
A look at some of the inventions of famous inventors such as R Buckminster Fuller, etc.

6f Lesson "Patents" 20 minutes
Discuss patents: what they are; why people want them; how to go about getting one; etc.

Assign activities from Appendix B as appropriate. It is effective to let students choose among several possible problems so that all of the class is not working on the same problem. This provides the opportunity for pupils to learn from each other. Emphasize:

problem solving process: student work should reflect the process and how he/she got to the end product

documentation: record keeping of each step in the problem solving process as a reflection of the student's thinking

generating solutions: most difficult step of process and requires the most teacher encouragement

# MODULE 3: HISTORY/ EVOLUTION OF TECHNOLOGY

The third module in the Introduction to Technology course is the study of the history and evolution of technology. This study should not be limited to looking backward to the past but should also include a look forward to the future, where our students will be spending all of their lives.

## III.1 Module Objectives

1. To provide students with a perspective view of the history of the technological developments of humans including major inventions and innovations which have had a great impact on civilization.

2. To develop the ability to distinguish ways in which technological developments in agriculture, medicine, communication, transportation, production and other technologies have caused changes in culture and society.

3. To excite and motivate students to apply the knowledge of past technological developments to new and future technology.

## III.2 Background for the Teacher

Technology has been around since humans first fashioned a stone to use as a knife, a hammer or a spearpoint. The need for survival brought about solutions to common problems of food, shelter and clothing for protection against the environment. Although the evolution of these devices came about extremely slowly for the first several hundred thousand years, these evolutionary changes are accelerating in pace. In the last few hundred years the world has witnessed revolutionary change in these primary survival and other technologies. It is said that over 90 percent of the human-made things around us have been invented in the last 75 years.

Putting these changes in perspective for the student is an important but difficult task. Many children have taken a strong interest in computers, for example, and cannot visualize a world where computers do not exist. Yet the first crude microcomputers were introduced in 1974, just a few short years ago. Television is also something most people take for granted. Its wide-spread introduction following World War II began to have an impact on family life, commercial marketing strategies and many other elements of the social and business structure. But most of our students probably take for granted that television has, for the most part, always been around. They cannot imagine a world without television.

There is evidence that about 45,000 years ago an evolutionary milestone was reached: humans acquired the ability of speech. Although there is evidence of stone tools dating back 2 million years, more sophisticated versions appeared in Asia and Europe 750,000 years ago. However, the stone tools developed by later "modern" humans at around 40,000 years ago, show tremendous improvements over the old techniques and indicate to scientists that a new kind of mind was at work.

Using the mark of 40,000 years ago as an arbitrary starting point, we may divide a timeline from that point until the present into a series of "lifetimes", each lifetime being an average of 66 years in duration. When divided, 40,000 years yields approximately 600 "lifetimes" or 600 full life spans of people stretching back to the discovery of the "modern" stone toolmaking techniques.

It could be said, therefore, that 90 percent of all the things around us were invented within just a little more than the last "lifetime." Television, radar, electronic computers, antibiotics (1940), nuclear energy, DDT, jet aircraft, liquid-fuel rockets, laser, communication satellites, fiber optics, talking pictures (movies), synthetic fibers, and many, many more have arrived on the scene in the last 66 years. The printing press (1455 AD) was invented just 8 "lifetimes" ago; the telephone (1878 AD) just 1.5 "lifetimes" ago; the chariot, 62 "lifetimes" ago; paper, 28 "lifetimes"; and so on. Discussing the printing press as something which occurred in 1455 AD has little meaning to a student who has only seen twelve or thirteen years of life. Dates such as 1455 AD or 1609 AD (astronomical telescope) are merely numbers and seem a part of a distant past. But when viewed as events which occurred just 6 or 8 "lifetimes" ago, they are events which seem somehow closer to our current age. We are truly not that far removed from those times.

Humans walked the earth for literally millions of years before advancing from the most basic technological tools-- stone knives and clubs as extensions of the human hand. Now, in the last two and a half lifetimes, humans have moved from horses to steam trains (1825) to cars (1885) to airplanes (1903) to walking on the surface of the moon (1969). The individual who invented the automobile could have discussed his invention with the grandparents of one of your students. And the same thing could be said of so many of the things we use daily and don't even think about.

In the 600 "lifetimes" since the emergence of modern humans, almost every single item we see around us was developed in this, the last 600th "lifetime". How, then, did people function and thrive up until this time? What was the life a person like just 5 "lifetimes" ago?; 10 "lifetimes" ago? We are all incredibly dependent on technology our grandparents only just saw introduced during their own childhood, that if it were taken away most of us would probably die. Wide spread famine, disease and social breakdown would most likely result if only one resource of our era was taken away from us: oil.

The incredible change which has occurred within this last "lifetime" is very difficult to comprehend. The effects of these changes will not be understood for a very long time. We are just beginning to perceive the effects of copper and bronze technology on the peoples of 3000 years ago. But although this task is difficult we can begin to see the effects of technological change on our own world if we make the effort. Using the insights gained from looking at the impacts of earlier technologies on people and the environment, we can sometimes draw parallels with new technologies we encounter.

Developing this awareness in students is important. In our lifetimes, we have seen vast technological change and felt the impacts of these changes on our lives. Every indication points to an increasing rate of change in the future--and the future is "where" our students will live.

## Specific Suggestions:

Presenting the history and evolution of technology involves more than showing a film and talking about inventions. Students should become part of this history by experiencing the true inventive spirit of past and present innovators. The spirit can be generated by the use of design/problem solving activities which vary in format. There are several board and computer games on the market whose intent is to quickly develop students' interest in gaining knowledge about simple tools and machines. These tools and machines may be combined on-screen into more complicated systems.

The intent of this module is to bring history to life by providing experience with some of technology's greatest discoveries in a way that stimulates the student to seek out and solve her/his own problems. The environment of the classroom can be transformed into a technology awareness exhibit by using some of the following ideas:

1. Place a time line chart of historical developments on a wall or bulletin board.
2. Have pictures of inventions and their inventors on display around the room.
3. Have samples of simple inventions on hand for students to see.
4. Hand out time-line charts.

5. Place a string or wire across the room and hang pictures or names of inventions or great technological discoveries on the string with dates to show their position in history. Get students involved in this project (Appendix B, Activity M 3.6).
6. Have photos or drawings illustrating the various phases in the development of manufacturing.
7. Have models of historical structures on display. (Good paper cut-out models are available for famous buildings and bridges).
8. Develop a bulletin board which features an invention or device. Trace its development.
9. Set-up a reference library so that students may research technology during the class period. Set up a lending system (you may want to get students involved in setting up the lending system).

The following list reflects some of the most influential inventions in history. The seven simple tools/machines are marked with an asterisk (*). Once invented, these became the basis for many other revolutionary innovations. Demonstrations should illustrate the scientific principles, development and use of these inventions as well as the impact they have had on our world.

*LEVER---*WEDGE---*WHEEL---net---rope---knots---chain-----adhesive---solder---gear---*SPRING---valve---
*CAM-----wire---crank---*PENDULUM---*SCREW and SCREWDRIVER-----air pump---universal
joint---governor---ball bearing-----telegraph cable---photoelectric cell---aerosol spray-----vacuum
tube---transistor---laser---superconductor (?)---------->

There may be more which could be added to this list.

There are several sources of media which tell the stories of inventions and inventors and the evolution of technology. A very fine series has been produced entitled "Connections" by James Burke. This series consists of ten, one-hour programs depicting the evolution of certain technological inventions and the impact of these inventions on the world. The series covers over 100 inventions and technological events that have changed the course of history. The series requires a minimum of 20 hours including showing and discussion time, and demonstrations and student activities associated with each episode. This series has been followed by a new series entitled "The Day the Universe Changed." In the new series, Burke expands on many of the events covered in Connections.

It is unlikely that the teacher would choose to show all of the episodes of these video series. But by previewing and carefully choosing specific episodes and/or segments of episodes, the teacher has an excellent resource of interesting and entertaining media dealing with the development and impacts of technology.

## III.3 Strategies for Meeting Module Objectives:

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**Objective 1.** Provide students with a perspective view of history of technological developments

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Lesson or Activity

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1a Show video: "You, Me and Technology: #1", if available.
Demonstrate the seven major inventions indicated above (*).

1b Lesson: "The Changing Nature of Work" 30 minutes
Look at the life and kind of work most people had to look forward to in the medieval period (farming); the life and work of the colonial period (farming, trades, military, etc.); the life and work of the American industrial revolution period (farming, factory worker, etc.) and put students in the place of people their age at these times (some married, all working dawn until dusk, etc.)

1c Field Trip: Historic village from list in Module 2.

1d Activity: Time Line (Appendix B, M 3.6)

1e Activity: Quill Pen (Appendix B, M 3.7)

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**Objective 2.** Develop the ability to distinguish ways in which technological developments in agriculture, medicine, communication, transportation and production have caused changes in culture and society

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Lesson or Activity

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2a Lesson: "Inventions that Changed the World" 30 minutes
Show examples of inventions which had a dramatic impact on the world, such as the plow (started civilization), sail (its evolution), the mechanical clock (lead to accurate navigation), the telescope (lead to revolution in thinking about the nature of the earth and its place in the universe) and others.

2b Try "Great Pyramid" activity (Appendix B, M 3.8) with class. Discuss the incredible achievement of designers and builders of this structure

2b Use segments from episodes of "Connections" or "The Day The Universe Changed" to show impact of particular inventions and technological developments.

2c Activity: Have students try and accomplish a task with tools and materials of another age, such as Activity M 3.3 Old Log Cutter.

2d Activity: Have students gather information on "superconductors" and lead a class discussion in possible ways this development might change our lives.

**Objective 3.** Excite and motivate students to apply knowledge of past technological developments to new and future technology.

Lesson or Activity

3a Activity: Develop a display of products which begins with things of today (actual products, pictures or mock-ups) and continues to the year 2050. Students should make models of these products with an explanation of what they do (and how they work if appropriate). For example, the display might include a digital calculator wrist watch for the year 1987; the year 1995 might have a telephone built into it; the year 2010 might have a watch which provided both a phone and a satellite link to a central computer system for data; the year 2040 might have the watch capable of a holographic display in air with touch screen along with the video telephone.

3b Field Trip: Smithsonian Aerospace Museum, Washington, DC. Look at flight in past, present and future. Also, Franklin Institute, Philadelphia, PA

3c Speculate on contact with an extraterrestrial intelligence and the possible impacts of finding it (discuss NASA's efforts at SETI: Search for Extraterrestrial Intelligence). Some science fiction short stories would be interesting here to help the discussion along; either read to class or give as a homework reading assignment prior to discussion. Key ideas are: it's difficult to find a case in human history where a superior civilization did not take advantage of a lesser one; advanced technology is indistinguishable from magic (imagine a medieval scientist getting a look at a pocket calculator: obviously the devil's work!); too much technology too quick causes culture shock (some third world countries are experiencing this today).

# MODULE 4: SYSTEMS OF TECHNOLOGY

The understanding of systems can be helpful to students in learning about technology by providing a conceptual model which will stand up to almost any instance of technology. Models help us understand something previously unencountered by providing a framework to hang our ideas. If a simple device such as a hand drill or a complex process such as generating electricity from the burning of coal both have the elements common to a system, then a system which we have never been exposed to before will also have those same common elements. Systems such as robotic material handling or toxic waste incineration may be broken down into their elements and understood as a system in terms of the resources input to the system, processes employed and outputs produced. These systems are not unlike more simple systems we encounter every day.

## IV.1 Module Objectives

1. To develop the ability to use a systems model to explain an instance of technology.
2. To understand how materials, information and energy are processed in systems
3. To distinguish between the four outputs of a technological system.
4. To develop a vocabulary of terms related to technological systems.

## IV.2 Background for the Teacher

### Systems:

Some current thinking suggests that a technological event occurs when several elements are brought together to satisfy a need or extend a human capability. When humans, tools/machines, energy, information, capital and time are brought together in order to fulfill a need or want (or extend a capability which would also be a want) then a technological event can occur which may result in an output, usually in the form of an artifact. The output or result can, hopefully, bring about the necessary change and satisfy the need or want. In some instances the need or want may be informational in nature, or a procedure for accomplishing a complex task. In another instance it could be shelter, a need, or recreational, a want. Resources, defined as **humans, tools/machines, materials, energy, information, capital** and **time**, are used in the processes of the technological system to produce a desired output (Figure IV.1).

When resources are combined in a process or multiple processes the intended result is the gratification of the need or want. It is easy to recognize the fact that in technological systems we get something else besides the original intent. When electricity is generated in a coal-fired plant, smoke and soot are often products of the system just as much as the intended electricity. When we get cars we also get traffic jams and highway deaths. To understand technology it is important that we also understand all (or as many as we can) of these consequences as well as the obvious and intended result of the systems we incorporate.

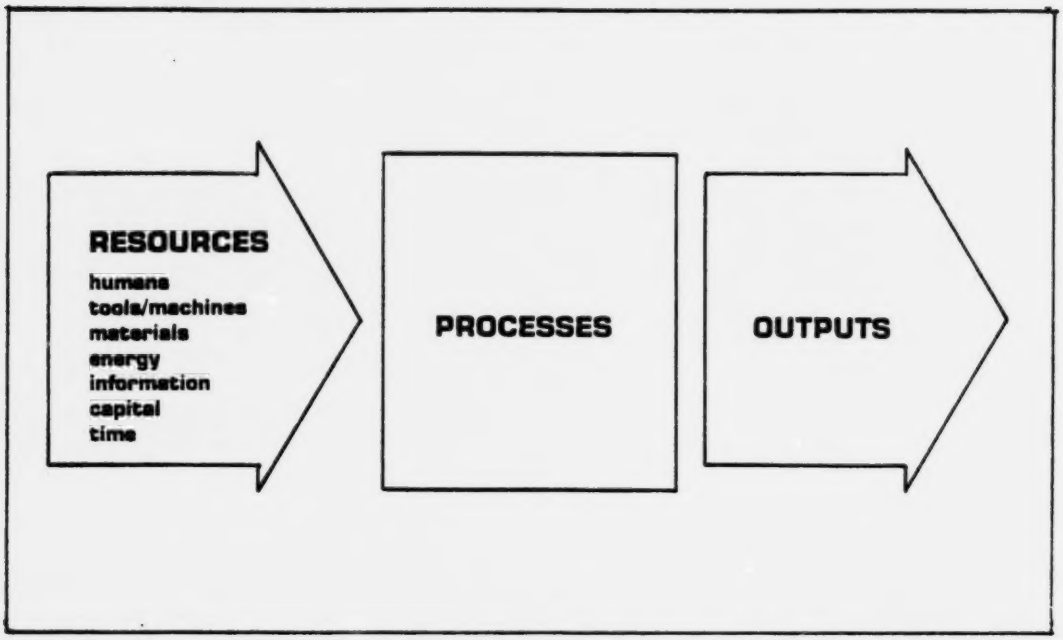



Diagram of a Technological System

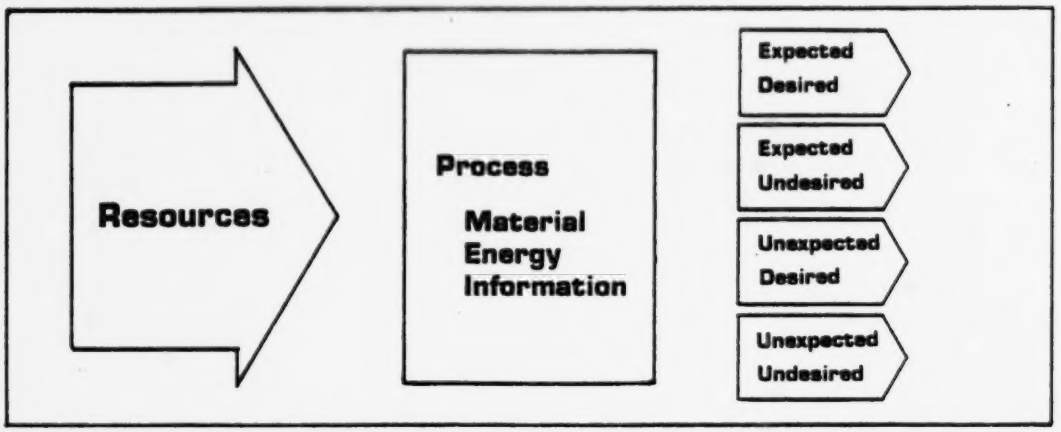
Figure IV.1

In the work going on in New York State, technology educators have outlined four categories of outcomes or results from the technological system. Loosely defined, these outputs include the **expected desired, expected undesired, unexpected desired** and the **unexpected undesired.** The expected desired output is the artifact or product of the system which was developed to fulfill the need or want. It is the result for which the system was put together in the first place. It is the computer, the aircraft, the toaster, or the electricity from the generating plant.

The expected undesired output is the by-product(s) of the system which can be expected to occur if the resources and processes of the system are employed. Burning coal produces heat which can be used to turn turbines to generate electricity. But burning coal also produces by-products of the combustion process which are known to pollute and cause smog, respiratory-related illnesses and other effects. These outputs are undesirable but we know they occur (see Figure IV.2).

The last two categories of outputs are more subtle and demand a closer analysis of the entire technological system employed. They may be long-range results as in acid rain or evolving lack of privacy in a highly computerized society but they are, nonetheless, just as important to the understanding of technology as is the shaping of materials or the workings of the computer. The unexpected outcomes, both desirable and undesirable, are sometimes the fundamental reasons for choosing to or choosing not to employ the use of certain materials, tools/machines, energy sources and technical processes as well as the products and artifacts resulting from such systems. In most cases, there will be multiple outputs in each category, except perhaps in the intended desired area.

Systems are often referred to as either open-loop or closed-loop. Open-loop systems lack feedback provisions and operate on a simple go or no go level. Closed-loop systems incorporate feedback techniques which allow for monitoring of the output and adjustment of some aspect of the input and, therefore, some phase of the process accordingly. The idea of control through feedback is an important development of technological systems and the introduction of the computer has literally revolutionized the productivity and efficiency of these systems.



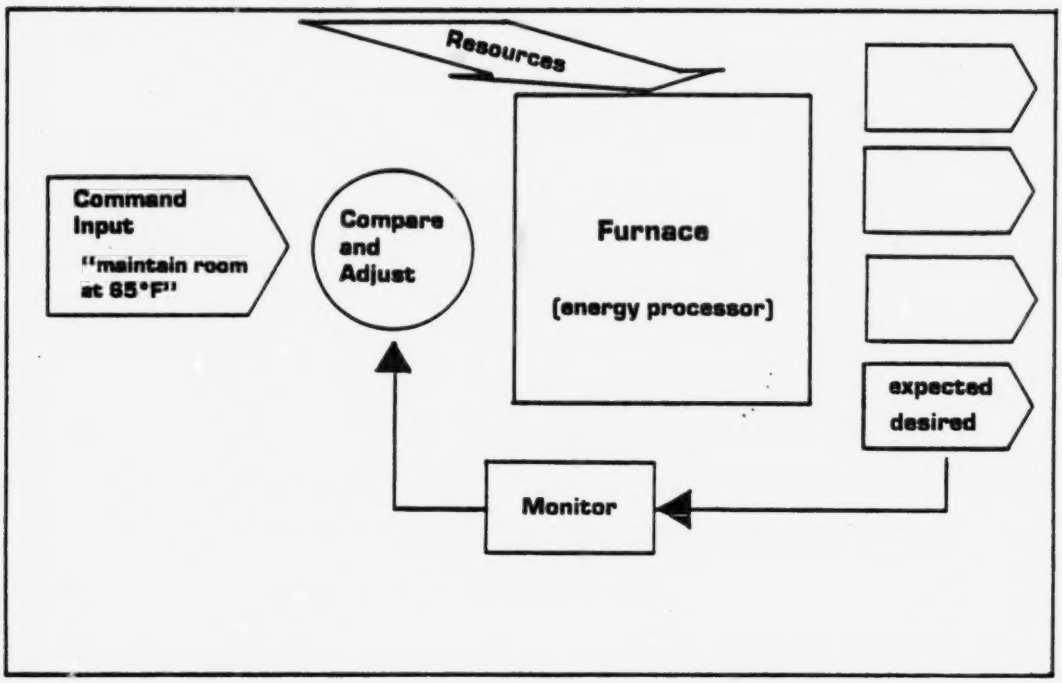

Outputs of A Technological System

Figure IV.2

In Figure IV.3 the resources are placed above the location in previous diagrams but are still processed and result in the four categories of system output. Three new concepts are introduced, the "Command Input", the "Compare & Adjust" and the "Monitor". Viewing the system in this manner makes sense of the closed-loop concepts. The command input is the desired result of the system. An example of a Command Input is "maintain a room temperature of 65 degrees". The Monitor takes a look at the expected output and channels it to the Compare & Adjust. In this example, it is the actual room temperature, say 60 degrees.

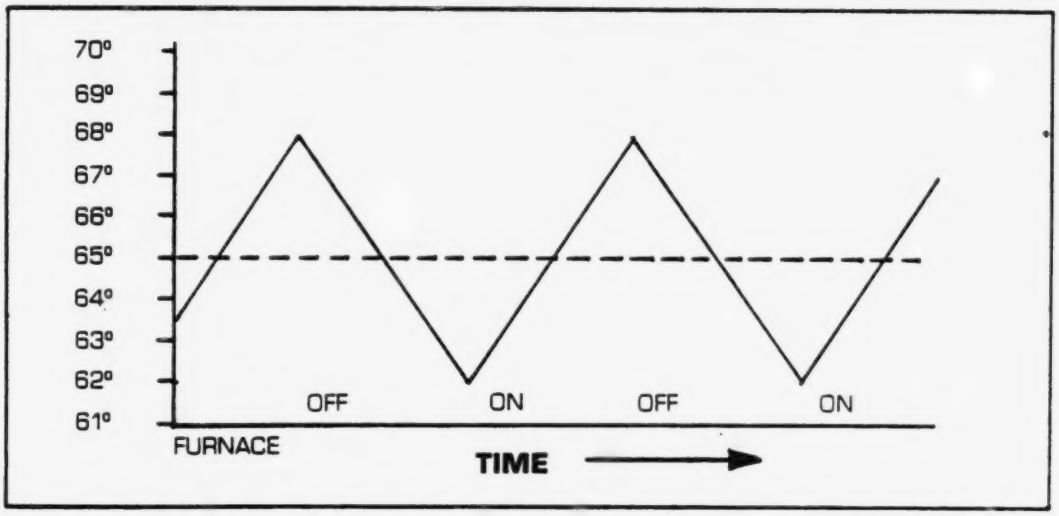
The Compare & Adjust is the part of the system which looks at both the Command Input and the results of the Monitor, in this case 65 degrees and 60 degrees. What is then done is a factor of how the Compare & Adjust is designed and to what accuracy. In the the room thermostat, a difference of 5 degrees between the intended temperature (Command Input) and the actual room temperature (Monitor) will usually cause the furnace to come on (Adjustment). When the desired temperature is reached (within the limits of accuracy for the thermostat) the furnace is shut down until adjustment is needed again. In this example of a closed-loop system, the temperature is constantly monitored and compared to the desired temperature. As room temperature rises to the desired temperature the furnace is shut down and room temperatures begin to fall.

If the room thermostat was constructed to turn the furnace on or off at a temperature very close to above or below 65 degrees, the furnace would rapidly cycle on and off attempting to maintain a temperature as close to 65 degrees as possible. A better design, in this case, is to build in a tolerance of several degrees above and below the set temperature so that the components of the heating system do not cycle rapidly and, therefore, will tend to last longer. An average of 65 degrees is maintained but in reality, the room temperature is always in a state of rising or falling around the set or desired temperature. Figure IV.4 shows a graph of room temperature set around a desired temperature of 65 degrees.




Home Heating System (Closed-Loop)

Figure IV.3




Room Temperature Over Time With Thermostat Set At 65 degrees
Example of Control in a Closed-Loop System

Figure IV.4

## IV.3 Strategies For Meeting The Module Objectives:

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**Objective 1.** Develop the ability to use the systems model to explain an instance of technology

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Lesson or Activity

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1a Lesson: "Understanding Systems" 20 minutes
Using overheads, go through the resources, processes, outputs of systems beginning with a very simple example. Get examples of technology from class and analyze on chalkboard. Breakdown examples into sub-systems where appropriate. Do not introduce four categories of outputs at this time.

1b Activity: Analyzing a system- Use a systems model worksheet (a system block diagram with just symbols) and have students analyze various machines in the laboratory in terms of each machine's resources, processes and intended output.

1c Homework: Do system analysis activity on a technological device in the home.

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**Objective 2.** Understand how materials, information and energy are processed in systems

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Lesson or Activity

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2a Lesson: "Processing Materials" 40 minutes
Overview of how materials are changed: shape change through forging, casting, etc.; addition through welding, gluing, fastening, etc.

2b Activity: Paper Construction (Appendix B, M 3. )

2c Lesson: "Processing Information" 40 minutes
What do we mean by information processing? What is information? ("patterns of energy and/or materials intended to convey meaning"); if we process information we must alter it in some way. Communication is when information or an idea is successfully sent and received, either by human to human, human to machine, machine to human or machine to machine (animals too). The "processing" is the altering of the original information (encoding) in order that it may be transmitted; the actual transmission of the information; reception of the coded information; and the decoding of the information. In this case information is being processed for communication purposes. Information may also be collected (sensors), stored, sorted and classified, manipulated by mathematics, and retrieved.

2d Activity: Hydroponics (Appendix B, M 4.3)

2e Lesson: "Processing Energy" 30 minutes
Energy comes in six forms and may be changed from one form to another (theoretically). Provide examples and demonstate: photovoltaic cell; thermocouple (heat to electrical) and/or thermostat spring (heat to mechanical); piezoelectric (crystal microphone or phono cartridge); others.

2f Activity: Energy Converter (Appendix B, M 4.2)

**Objective 3.** Distinguish between the four outputs of a technological system.

Lesson or Activity

3a Lesson: "Outputs of Systems: The Impacts of Technology" 20 minutes
Introduce the idea of four outputs from every system. Use plenty of examples from systems familiar to students: TV, computers, etc.

3b Field Trip: visit a local waste treatment facility, power generation station or water works. Familiarize students with broad systems they will encounter at visit site prior to trip. Have them look for last 3 outputs and record. De-brief upon return to class.

**Objective 4.** Develop a vocabulary of terms related to technological systems.

Lesson or Activity

4a Homework: Find examples of devices around the home which utilize the following concepts:
open-loop system
closed-loop system
Write a description of each device and point out the components of the system (input command, process, etc).

4b Have a team of students plan and make a professional looking wall display depicting a closed-loop technological system, pointing out input, resources, processes, outputs, monitor, etc.

# MODULE 5: RESOURCES OF TECHNOLOGY

Understanding resources is the key to understanding technology and the consequences we face as a result of the choices we make. The resources necessary for technology to take place are: information; energy; materials; tools/machines; time; capital; and humans. Students should become aware of various choices within these resource categories and some of the advantages and disadvantages of these choices.

For example, studying material resources should provide the student with an understanding of various material properties, where and how these materials are obtained and some limited experiences with how these materials are processed. A study of energy resources should make the student aware of where these resources are obtained, how they are used and known impacts of various energy source use.

## V.1 Module Objectives

1. To familiarize the student with the seven resources of technology.
2. To develop an awareness of the forms and major sources of energy.
3. To expose students to a number of different materials used in technological processes and examine their properties.
4. To develop an understanding of the similarities among machines and tools as extensions of human capabilities and senses.
5. To develop an understanding of how information is managed and its role in a technological society.
6. To develop an awareness of the role of capital in driving technology in our society.
7. To develop an awareness of the importance of time in a technological society.

## V.2 Background for the Teacher

This module addresses a wide variety of topics around the theme of resources. Resources are the elements necessary for technology to occur. Understanding how these resources are choosen, where they are obtained, how they are processed in technological systems and the impacts and consequences of resource depletion are some of the topics in this module.

## Energy:

Energy is defined as the ability to do work. There are six forms of energy, including:

**motion** (mechanical)
**heat** (thermal)
**light** (radiant)
**electrical**
**chemical**
**nuclear**

Theoretically, energy can be converted directly from one form to another. In reality, however, it is often easier to convert energy through intermediate forms. For example, chemical energy may be converted directly to electrical energy in a battery. But chemical energy locked in petroleum is usually converted to heat energy (burned) to run a turbine (motion) which turns a generator and produces electrical energy.

When energy is converted from one form to another, some of the original energy is lost to us because it take on an unusable form. Electrical energy converted to motion through a motor provides a good example. All of the electrical energy is not converted to motion--some is converted to heat in the friction of the motor bearings. Also, the wires connecting the electrical energy source to the motor, and the armature windings of the motor itself, heat up, using some of the original energy. This heat energy is not now available to turn the motor, so the output of the motor is less than the input energy of the source. The energy which has been lost in the form of heat is known as entropy. Entropy results from conversion from one form to another and is in a form which is not usable.

Sources of energy are where we obtain a certain form. The sun is a source of light energy; a battery is a source of electrical energy; gasoline is a source of chemical energy. Resources, when describing energy, are usually thought of as supplies of "raw material" of certain forms of energy. A resource for chemical/heat energy is petroleum because we can make gasoline or fuel oil from it.

Energy resources may be divided into non-renewable and renewable. Resources such as coal, petroleum, natural gas and uranium are non-renewable because, for all practical purposes, there is a finite amount of these materials in the crust of the earth and no more. Renewable energy resources are those which seem to have a nearly unlimited supply. Solar energy, wave, tidal and geothermal energy resources are continuously available, although in a form which is more diluted than many of the non-renewable resources.

The consumption of energy is an important issue of our time. Energy resources commonly used are of the non-renewable variety and controlled by countries in an unstable part of the globe. As a nation, we have witnessed petroleum shortages just over a decade ago, but since that time, have done little to change our overall dependence on imported oil from these regions. Understanding our energy use and the increasing consumption rates is an important part of technological literacy.

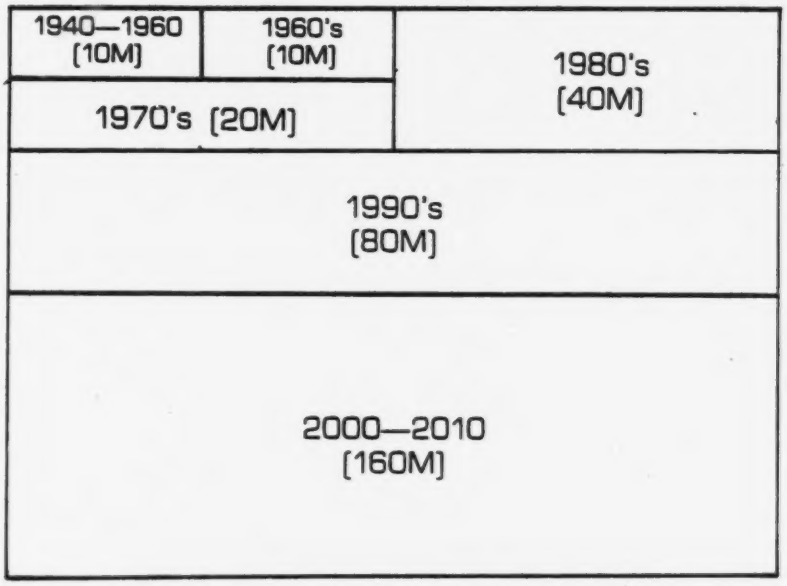
The concept of exponential growth or "doubling" is not widely understood and is a powerful tool to bring home the concepts of increasing energy use and increased resource consumption. A growing country, for example, consumed 10 million bushels of corn from 1940, when it was first introduced, until 1960. It then used the same amount (10 million bushels) between 1960 and 1970. Its consumption for the 10 years (1960-1970) was the same amount used for the previous 20 years of the country. During the next decade, 1970 to 1980, the country used 20 million bushels. This is double the consumption for the previous 10 years. The latest figures for the country show that 20 million bushels of corn were already consumed between 1980 and 1985, so at that rate 40 million bushels will be consumed by 1990. The doubling rate of corn consumption by this country seems to be holding at 10 years. In other words, every 10 years, the country uses as much corn as was used in all the previous history of the country (see Figure V.1). At this rate, 80 million bushels of corn will be required to feed the population between 1990 and 2000; 160 million between 2000 and 2010; and so on.

If the country continues to grow at its present rate, it will continue to double its corn consumption every 10 years, but populations tend to increase their rate of growth over time. Therefore, the time for corn consumption to double will get progressively less.

To see the impact of "doubling time" you may use a chess board. Place 1 of something, such as a grain of rice, on the first square in the upper left corner. On the square next to this, place two grains of rice; the next, four grains; the next, 8 grains, and so on. Each time doubling the amount on the previous square. The squares represent the "doubling time", 10 years in the case of corn consumption in the country above. The amount of rice in the square represents the amount of the resource whose demand has doubled. It is said that the last square on the board (64 squares on a chess board) would have to contain all the rice ever grown on earth in all the thousands of years humans have been growing it, and still there would not be enough to double from the previous square.

The same can be done starting with very insignificant numbers such as the thickness of a dollar bill (about 0.004"). Have students guess how thick it would be if it were folded four times? 10 times (2 inches)? 35 times? 43 times? (it is about the distance from the earth to the moon). Doubling sneaks up on you very fast. Nothing seems to be changing much for quite awhile, then, all of the sudden...! You don't even get to an inch thick until fold number 9.

World oil consumption has been doubling about every 10 years. Where once a new, large oil field would provide crude petroleum for several years of use, now it will only provide enough for several days of use (in reality, it will still take years to get it out of the ground). Even if we found massive new fields to exploit, they will only provide petroleum supplies for a short time because of the world's increasing use of oil.




Example of "Doubling Time"

Figure V.1

## Tools and Machines:

The purpose of the tool or the machine is to extend a human sense or capability. A pair of pliers supplements the ability to grasp; the microscope, the sense of sight. Most tools and machines are easily recognized for the human capability they extend.

Mechanical tools and machines employ one or more of the five "simple machines", including the lever, wedge, screw, pulley and the wheel and axle. Study of the simple machines helps to make the principles of operation and function of tools and machines clear. Machines may be divided into their sub-systems: support and cover; power transmission; and guidance and control (Todd 1985).

According to common definition, machines are complex devices which process material, information and/or energy for some useful purpose. Familiar material processing machines include machines which drill, saw, fold, weld, etc. Information processing machines may either be mechanical, such as the older crank-operated calculators, or electronic. Newer machines often combines the functions of material and information processing as in the Computer Numerical Control (CNC) lathes, mills, etc.

Energy processing machines convert energy from one form to another. A gasoline powered portable generator for site construction work is an energy processing machine. Most materials processing machines combine energy processing with material processing to utilize electrical or chemical energy to provide motion for the cutting, welding, or other operation it is designed to perform.

## Materials:

Materials may be classified into natural materials and synthetic (human-made) materials. There are also materials which are natural, but have been altered to change some characteristic. Natural materials include wood, clay, metals, etc. Synthetic materials include glass, plastic, concrete, and industrial diamonds. Some altered materials are leather, fabrics, chipboard and paper.

The characteristics of materials are important because they effect the choices we make about the suitability of materials for specific purposes. Important characteristics include:

**physical**
**chemical**
**electrical**
**magnetic**
**thermal**

For instance, the thermal characteristics of a material are important if we want to prevent heat from escaping from a container, such as a "cooler", or from house walls and ceilings. The electrical characteristics of a material are important if we want to insulate the handles of a pair of wire cutting pliers or build an electrical switch. The design and building of structures will be influenced by the physical characteristics of the materials employed. An awareness of these characteristics is important aspect of the understanding of materials.

Testing the properties of materials is a good way to become familiar with their characteristics. Physical properties, such as hardness, elasticity, plasticity, ductility, ability to withstand compression, tension and shear, are relatively easy to test with student designed and built devices. The devices do not have to be sophisticated and may simply provide a comparison between two or more materials for the same property (Ray Shakelford, from Ball State University, has published several articles on material testing activities for junior high students which provide excellent examples of what can be taught). The design and construction of such equipment are good activities for a unit on materials.

Materials may be processed by a number of different methods in order to separate, join (including mixing with other materials, coating the surfaces, etc.), change their shape, or change the internal structure. Materials processing should be taught with the transferrability of the information given to students in mind. Learning to work wood uses many of the same skills used to work some plastics. Many processes used for metal work are appropriate for working wood and plastics. Emphasizing the similarities (and pointing out the specific differences, and why) makes the knowledge useful in a broader context. And where differences exist, point out the characteristics of the materials which demand that different processes or techniques be employed.

### Time:

Time keeping has had an important impact on civilization. Ancient priests held their power by being able to successfully predict when seasons would change and rivers would flood. This information was not available to the common person. In medieval ages, monks developed time keeping mechanisms to permit them to pray at the same times during each day. Later, when sailing technology advanced, accurate timekeeping became very important to navigation and with it the quest for lighter, more reliable clocks.

Time can be measured in reference to celestial movements (earth, moon) or in reference to some arbitrary cycle or movement (flowing of water out of a vessel, the swing of a pendulum or the vibration frequency of the hydrogen atom). Devices which measure the passage of time make a fascinating study of ingenious devices and mechanisms.

## V.3 Strategies for Meeting Module Objectives:

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**Objective 1.** Familiarize students with the seven resources of technology

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Lesson or Activity

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1a Lesson: "Resources of Technology" 20 minutes
Discuss seven resources; give examples from systems familiar to students

1b Show "Toast" film on resources which go into producing a piece of toast.

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**Objective 2.** Develop awareness of the forms and major sources of energy

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Lesson or Activity

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2a Show video: "Energy: The Fuels and Man"

2b Homework: Students will keep a log for one day listing all the processed energy forms they use and the conversions back to the sources (example: ride home in bus - mechanical energy from heat in engine through gasoline (chemical) and gasoline refined from crude petroleum; shower with hot water - water heated by electric water heater, utility's power plant runs on coal; etc.).

2c Activity: Solar-Powered Vehicle (Appendix B, M 5.1)

2d Activity: Wind Measurement (Appendix B, M 5.2)

2e Show video: "Energy: The Problems and the Future"

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**Objective 3.** Expose students to a number of different materials and examine their properties.

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Lesson or Activity

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3a Activity: Paper Construction (Appendix B, M 5.3)

3b Activity: Give out a design brief for a simple problem. Divide the class into several groups and limit each group to only one material which can be used in solving the problem (a different material for each group). When solutions are developed and constructed, as a class discuss the advantages and disadvantages each group had working with their assigned materials. Use an introduction to the properties of materials.

3c Activity: Bake Bread - Use this as a material processing activity where a number of changes are made: ingredients are combined; the shape is changed (pressing, casting); internal changes are made (baking); etc.

3d Materials Testing: Set up testing jigs for compression, tension or shear and test various materials of the same dimensions.

3e Activity: Run a product test on glues: Use strips of index card stock (or similar) cut to 1/2" wide. A 1/2" overlap glue joint is made with two strips and allowed to dry overnight. One end of one strip is fastened in a bench vice with the strip hanging down vertically; a small clamp (block of wood on either side of paper strip) connects the paper strip to a plastic bucket; begin filling the bucket with sand; weigh the bucket and sand at failure; keep a chart of performance of various glues, including library paste, white glue, hide glue, stick glue, egg white, etc. Some joints will be stronger than the material itself. The same activity could be done with small wood strips if sufficient weight can be found to cause failure. Summarize findings and display.

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**Objective 4.** Develop understanding of the similarities among machines and tools as extensions of human capabilities and senses.

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Lesson or Activity

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4a Develop a display of different tools which extend the same human capability or sense (tools which extend sight would be easy). Try to get the widest variety possible from different occupations, etc.

4b Activity: Design and build a simple device which extends some capability or sense. State the capability or sense before beginning design work.

4c Analyze young childrens' toys which contain mechanisms. Demonstrate the toy and ask students to sketch a mechanism which would duplicate the motion produced in the toy. Push toys which have 'bobbing' tops are interesting because cams, eccentrics, cranks, etc. will all produce a similar motion.

**Objective 5.** Develop understanding of how information is managed and its role in a technological society.

Lesson or Activity

5a Introduce word processing - demonstrate the advantages over conventional typing. Have students word process an assignment. Correct assignments and have students them redo to perfection.

5b Use a simple CAD or DRAW program (many are available as public domain programs for free) on a microcomputer to demonstrate basic principles. Have students do an assignment using CAD. Avoid more complicated commercial CAD software because too much time is needed to become familiar enough to do anything with it. Discuss the advantages and disadvantages of drawing/drafting with this method over conventional paper and pencil.

5c Write your name and address in ASCII, Hex and/or binary digits, then write a message for another person to decode in the same language. Decode another student's message. Discuss the need for standardization in codes such as those used for computer printers, etc.

5d Lesson: "Accessing Database Systems" 20 minutes
Using a microcomputer and a modem, access a commerical or free private database or 'bulletin board system'. Show students some the knowledge needed to access information, free programs, etc. Discuss the kinds of information which is available through on-line databases.

**Objective 6.** Develop an awareness of the role of capital in driving technology in our society.

Lesson or Activity

6a Activity: Do a problem solving activity where each student begins with an amount of paper money. Resources (materials, tools, etc.) must be purchased or rented at a fixed rate to solve the problem. Students may also purchase or rent resources from other students but they may charge whatever the market will bear.

**Objective 7.** Develop an awareness of the importance of time in a technological society.

Lesson or Activity

7a Lesson: "Time, It's All Relative" 20 minutes
Look at time measurement through the ages: early humans only concerned with daylight and seasonal changes; medieval age, monks wanted to pray at regular times, time as a factor in navigation; industrial period, time as a work-related commodity (punching in); the technological age, measured in nano-seconds in microprocessors, burn times for space travel and navigation. Show examples of devices which measure time.

7b Activity: It's About Time (Appendix B, M 5.4)

# MODULE 6: CONTROL TECHNOLOGY

The area of Control Technology has the potential for a large number of interesting and exciting student activities. Because the concept of control is common to almost every facet of modern technology, students will be exposed to ideas which cut across many technical disciplines. Similarities among electronics, hydraulics, pneumatics and mechanical control systems will help reinforce these common concepts and lead to a greater general understanding of the workings and principles of modern technology.

## VI.1 Module Objectives

1. To comprehend the relationships that exist among the different types of systems (mechanical, electrical, hydraulic and pneumatic).

2. To develop an understanding of the essence of control as related to physical devices.

3. To develop an expertise to a level of usefulness in design and construction of controlled devices.

4. To relate the concepts of control to commercial technological devices.

5. To develop an awareness of the impacts of controlled devices, in terms of automation, on society and the work place.

6. To identify the difference between machine intelligence and human intelligence.

## VI.2 Background for the Teacher

Control technology is a term used to describe the interrelationships of many diverse devices brought together within a system for the purpose of having the system function as desired. Control is an aspect of having a device perform a function when a human wants it to do so. Control can be as simple as having a light bulb illuminate when a switch is pulled, or as complex as a lunar robot controlled from an earth station.

The purpose of this section is to have students recognize that many technological devices incorporate some form of control. The intent is to demystify the "automatic" machine and to see that the machine's intelligence is nothing more than human intelligence incorporated into the design of the machine.

There are many different aspects of control as well as devices that can be controlled. To develop a significant understanding of control, one must be familiar with the components that make up a device. This section is designed to take the student through the various aspects of mechanics, electricity, hydraulics and pneumatics, for the purpose of having them understand that many parallel control schemes exist within these areas.

One of the more traditional examples might be that of the flyball governor, a device introduced several hundred years ago to control the speed of a steam engine or locomotive. This basic concept of negative feedback is utilized on the simplest of closed-loop machines (systems) and the most complex high technology devices. Through experimentation with simple devices, the student will develop an understanding of control and the ability to transfer that understanding to much more complex technological devices.

Real understanding of the aspects of control will come when the student uses problem solving/design procedures for the purpose of finding an appropriate solution to a well-designed problem. The use of gears, linkages, belts, motors, springs, batteries, sensors and computers will give the student the physical means to understand conceptually the finer nuances of control technology. This can be approached at many different levels, depending upon the grade and age of the student, time allotted and prior experience with problem solving activities.

The approach taken should include problems in which various types of control are needed within the solution. The student should be allowed to experiment with a number of different materials in a number of different situations. The control problem should not always be relegated to one type and form of control, but include several such as mechanical and electrical or pneumatic and mechanical. Solutions should arise from what is most appropriate from what is available.

With proper foundations, the teacher should move into the area of electrical and electronic control. Computers, having become a center of high-technology control, are not being used effectively for that purpose in the classroom. The use of the computer in parallel with the other types of control systems is essential in a well-balanced understanding of all aspects of control.

## Natural Control:

A look at nature can provide examples of control at work. Within our own bodies there are feed-back systems which monitor our need for oxygen and adjust heartbeat and breathing in accordance with activity level. Lie detectors monitor the "automatic" reaction most people have of increased perspiration rate when they are not telling the truth (although there is much controversy about the accuracy of the human-developed monitoring of this response).

The leaves of trees and plants turn color by monitoring the angle of light of the sun, and certain plants, such as the venus fly-trap, exhibit animal muscle-like responses to insects who stimulate certain sensors located on the plant. It is helpful to relate concepts of control to these natural systems because the student may be able to more closely identify with systems within their own bodies or familiar plants and animals. It is a short step from this point to discussion and activities of the biological-related technologies; sensing pulse rate or blood pressure is not unlike monitoring hydraulic line pressure. There are students who will feel more comfortable and interested in technology when it is related to natural systems and clearly beneficial applications.

## VI.3 Strategies for Meeting the Module Objectives

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**Objective 1.** Comprehend the relationships that exist among the different types of systems (mechanical, electrical, hydraulic and pneumatic).

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Lesson or Activity

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1a Lesson: "Devices That Transform Power" 40 minutes
Using an array of different devices, explain and show their function in transforming power. Electrical transformers (step-up, step-down), gear trains (step-up, step-down), and pneumatic cylinders (syringes) of different diameters. Emphasize the over-riding concept that energy is neither created nor destroyed-- only transformed.

1b Activity: "Comparing the Input to Output of a Power Transforming Device" Have groups of students select one of the several devices and determine the characteristics of the inputs versus outputs. Electrical transformers could be analyzed for input voltage versus output voltage; the gear train analyzed for speed differences (revolutions); and the pneumatic cylinders for stroke travel.

1c Homework: Do an analysis of devices in the home which use the characteristic of transforming power.

1d Activity: Divide the class into three groups and assign each group one of the systems above. The groups are then to configure one the systems to control a light switch from a distance at least 10 feet away.

1e Activity: Lift an object (10 lbs.) 0.5 inches off a table top by applying a 2 lb. force.

1f Activity: Examine closely a large construction vehicle. Determine how mechanical advantage is used to enhance the power of its blade or arm. Model the mechanical system in 2 or 3-dimensions.

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**Objective 2.** Develop an understanding of the essence of control as related to physical devices.

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Lesson or Activity

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2a Lesson: "Identifying Control Systems" 40 minutes
Using examplesfamiliar to the student, identify some of the common control systems and characteristics that classify them as a control system. A look at the function of the automobile control systems such as the accelerator pedal, carburetor and engine will identify the relationship of linkage as a control system; similarly, a gear shift, brake pedal or a timer on a windshield wiper system. Additional examples of control systems may be drawn from the student's home. The heating/air conditioning thermostat, the door bell, the refrigerator timer/sensor for outdoor lighting systems. Begin hinting at the idea of open-loop and closed-loop systems as associate with the material in the SYSTEMS module. The general concept to be emphasized is that without some form of control, devices would not be able to function. Be sure to identify the simplest of control to the most complex.

2b Activity: Using 1/2 inch strips of posterboard or light cardboard, a piece of homosote or corkboard and pushpins, have students design linkages to do the following:

transform circular movement into reciprocating linear motion;
transform a 1/4 inch movement into a 1 inch movement;
have a reciprocating linear movement transformed into a continuous linear movement.

2c Homework: Hve students select a favorite "action toy" and describe all of the control systems utilized.

2d Activity: Give some thought to how a marquis sign is caused to flash lights in sequence. Design a scheme to replicate this function.

2e Activity: Design and make a "bumper sensor" which will detect and indicate when a golf ball hits it.

2f Activity: Design a cam that will allow a "square wave" to be drawn on a rotating drum.

2g Activity: Using four cams, a motor and four micro-switches, design and build a device that will cause the bulbs to light in a revolving sequence.

2h Design and build a device which will follow a pre-determined pattern or couse using a cam to control the steering.

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**Objective 3.** Develop an expertise to a level of usefulness in design and construction of controlled devices.

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Lesson or Activity

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3a Lesson: "Switching With Electricity" 20 minutes
A demonstration lesson on simple circuits using batteries, DC motors and switches. Explain SPST, SPDT switches and what can be done with them. Introduce the DPDT switch and show the logic behind using this switch to reverse the polarity on a DC motor to reverse its rotation.

3b Activity: Incorporate simple switching into a battery-powered device.

3c Lesson: "Relays" 15 minutes
Show a DPDT relay and micro-switch to reverse a DC motor on a small vehicle (or similar). Demonstrate that by incorporating the relay, the motor can be reversed with a simple SPST switch.

3d Activity: Have students set up a circuit using a DPDT relay and micro-switch to reverse a DC motor on a vehicle when the vehicle bumps against an obstruction.

3e Lesson: "Capa citor" 10 minutes
Simple demonstration to show what happens when a large (4700 µf) capacitor is attached in parallel across the relay coil terminals -- a time delay. Have students incorporate a capacitor into the vehicle above; experiment with different size capacitors.

3f Lesson: "The Transistor Switch" 30 minutes
Show a simple circuit for a NPN power transistor used as a switch. Do not go into the workings of the transistor at this time. Demonstrate biasing the base-emitter circuit with a small current and how photoresistors and thermistors can be used to turn the transistor on and off in a simple circuit. Incorporate the switching princples into a problem solving activity centered around the learned control circuit.

3g Lesson: "Introducing the Computer as a Control Device" three 40 minute lessons
Develop a demonstration which uses a classroom computer to control the turning on and off of small lights or LED's. Using the BASIC language or the LOGO language, indicate to the students the method by which output is directed to the light, and the timing routines which control the blinking. The teacher may have to introduce the fundamentals of programming if the students have no prior experience. The interface unit could be expanded to include more outputs as the level of students' abilities warrent. An introduction to the relationship of on-off settings and binary numbers may be appropriate at this time. The goal is to have the students able to program the light to generate a series of desired blinks. Later, the students may use this to turn on and off other devices, such as motors, relays or buzzers.

3h Show videos "Computers In Control" (Films, Inc.)

3i Activity: Students will select a sequence of on/off times (duty cycles) they wish to program. Example: on for 2 seconds, off for 4 seconds, on for 1 second, off for 1 second, and repeat. Should this theme be carried through, a student wishing to experiment may develop a system to flash the light for a particular letter in Morse code.

3j Activity: Writing a simple BASIC program which will turn on a number of lights in sequence.

3k Activity: Use a simple BASIC program to display the results of a sensor on the screen of a microcomputer. Sensors such as thermocouples, photovoltaic cells, linear potentiometers, etc.

3l Activity: Design a system to simulate the cycles of a washing machine doing a load of wash.

3m Activity: Design a system to detect the interruption of a light beam.

3n Activity: Construct a weather station as a class activity in which the data is logged by a computer.

3o Homework: Each student is to identify those items in the home which may have some form of computer used to control them. Be sure to have them investigate "mechanical" computers as well.

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**Objective 4.** Relate the concepts of control to commercial technological devices.

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Lesson or Activity

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4a Lesson: "Control Systems Used on the Space Shuttle" 20 minutes
Discuss the guidance, environmental control, launch control, communication, telemetry and landing control systems of the Shuttle.

4b Lesson: "A Look at Control Systems Used in an Automobile" 40 minutes
Using transparencies which show the basic systems of the automobile: braking; power transmission; fuel; ignition and cooling. Identify those systems which use a specific type of energy transfer system, such as hydraulic, electrical or mechanical. Identify those components responsible for controlling the system in either an open-loop or closed-loop fashion. Examples may include thermostats, pressure regulators, actuators, electrical contact and linkages. There are an abundance of items to choose; select those which your students can identify easily on their parents car.

4c Activity: Take students to local automotive repair station to see how a mechanic may use the different equipment to test and adjust the systems within the car. (or have older students in high school automotive classes do the same). Have the mechanic show the systems of a car to the students and see the car on the lift to view the underside. Don't miss the opportunity to show the hydraulic lift systems in the shop.

4d Activity: Use a home heating thermostat and set up a simple control system which will turn a light on and off according to preset temperature.

4e Activity: Devise a scheme to use a toy gyro-scope as a navigational control device.

4f Field Trip: Visit a factory or plant which uses automated machines.

4g Activity: List all the control systems you can think of in the human body.

4h Activity: Describe some of the control systems used in "action" toys.

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**Objective 5.** Develop an awareness of the impacts of controlled devices, in terms of automation, on society and the work place.

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Lesson or Activity

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5a Lesson: "Automation: Advantages and Disadvantages" 30 minutes
Discuss a brief history of automation; expected and unexpected advantages and disadvantages (impacts on individual, society, world market, etc). The purpose of this lesson is to take both an historical, contemporary and futuristic look at automation. This lesson may be ideal to team-teach with an instructor from social studies and may be suited to a joining of the classes where possible. Discuss the impacts of automation at the time of the industrial revolution in the U.S. Pay particular attention to labor practices, need for energy and power, resulting polution and the move from an agrarian society to overcrowding of the cities. Interesting sub-topic might include the development of many of our modern cities on waterways for access and waterpower. A current look at these topics is very appropriate. Discuss the move from a production society to a service society. A discussion of the trend of many high-energy need industries to the "sun belt"; labor practices and the introduction of labor laws and unions would also be appropriate. Identify how the introduction of high technology robotic automation may help/hinder future conditions in the workplace.

5b Field Trip: Visit a factory or other facility which utilizes advanced production techniques; automobile plants are usually very progressive.

5c Activity: Program a small robotic arm to move a piece of wood into position for drilling on a drill press. Try repeating the procedure several times and determine accuracy of drilled hole location. Integrate this with another project where possible.

5d Activity: Perform some form of simple product construction using the techniques found in the "cottage" industries prior to the industrial revolution. Do calculations of cost in time/materials/energy. Consider the energy consumed by the human (calories). Common diet tables may give a good idea of how much energy is consumed to perform certain operations. Produce the same product using machines with fixtures. Do the same cost analysis with respect to time/materials/energy. Be sure to include the energy consumed by the machinery.

5e Activity: Redesign a small power tool to work automatically and repeatedly.

5f Activity: Using Lego or Fischertechnik model a small automated production system

5g Homework: Make a listing of the products you think are produced with automated machines and those that were crafted by hand.

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**Objective 6.** Identify the difference between machine intelligence and human intelligence.

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Lesson or Activity

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6a Lesson: "Cybernetics: Machines and Humans" 30 minutes
Introduce to the students how a machine is made to process information. Show that humans are far superior to even the most sophisticated computer. Introduce the idea of artifical intelligence and describe where this concept now stands in development. A brief description of how the human brain functions and parallel functions in the computer would be appropriate. This lesson might be done in conjunction with a science lesson. The paralles between the human senses and machine senses and the current state-of -art. Emphasize the concept of sensing.

6b Homework: Have students make a list of things that, at this time, can only be done by humans.

6c Activity: Using your classroom conputer, replace the joystick with a thermistor. Write a brief program which displays the reading from the thermistor on the screen. Change the temperature of the thermistor and develop a table showing the results. Include this as part of the class weather station.

6d Activity: Devise a punch card system which can be used to sequence a series of events.

6e Activity: Design a machine controlled vehicle which can be steered by use of a punched card.

6f Activity: Investigate the average level of intelligence of modern robots.

6g Activity: Investigate historical examples of machine intelligence.

# TAXONOMY OF COURSE CONTENT

## MODULE 1.0 INTRODUCTION TO TECHNOLOGY

- 1.1 **What Is Technology?**
  - 1.1.1 Relationship Between Science and Technology
  - 1.1.2 Definitions
  - 1.1.3 Historical Progression
  - 1.1.4 Development of Technology
    - 1.1.4.1 Industrial Progress
      - 1.1.4.1.1 The Machine
      - 1.1.4.1.2 Mass Production
      - 1.1.4.1.3 Automation
      - 1.1.4.1.4 The Computer
      - 1.1.4.1.5 Cybernation
- 1.2 **Meeting Needs With Technology**
  - 1.2.1 Needs
    - 1.2.1.1 Physiological
    - 1.2.1.2 Social
    - 1.2.1.3 Psychological
- 1.3 **Categories of Technology**
  - 1.3.1 Physical Technologies
    - 1.3.1.1 Examples
    - 1.3.1.2 Career Outlook
  - 1.3.2 Informational Technologies
    - 1.3.2.1 Examples
    - 1.3.2.2 Career Outlook
  - 1.3.3 Biological Technologies
    - 1.3.3.1 Examples
    - 1.3.3.2 Career Outlook
- 1.4 **Using Tools and Materials**
  - 1.4.1 Tools and Processes
    - 1.4.1.1 Internal Change
      - 1.4.1.1.1
      - 1.4.1.1.2
    - 1.4.1.2 Separation
      - 1.4.1.2.1 Without Chip
        - 1.4.1.2.1.1 Sissors
        - 1.4.1.2.1.2 Xacto Knife
      - 1.4.1.2.2 With Chip
        - 1.4.1.2.2.1 Saw
        - 1.4.1.2.2.2 Rasp/File
    - 1.4.1.3 Addition
      - 1.4.1.3.1 Mechanical Linkage
        - 1.4.1.3.1.1 Vise
        - 1.4.1.3.1.2 Pliers
        - 1.4.1.3.1.3 Nails/Screws
      - 1.4.1.3.2
        - 1.4.1.3.2.1 Double-sided Tape
        - 1.4.1.3.2.2 Glues, Glue Gun
        - 1.4.1.3.3.3
      - 1.4.1.3.3 Coating
        - 1.4.1.3.3.1 Painting

# APPENDIX A: TAXONOMY OF COURSE CONTENT

The following pages contain a taxonomy of course content for Introduction To Technology. It is presented to provide the teacher with an overview of content and concepts important for the acheivement of the course goals.

Teachers should note that it is improbable that one course in technology can cover all the content outlined in this taxonomy. Teachers should use their own judgement in arriving at the focus areas appropriate for their particular instructional situation. Factors such as teacher background, length of course, length of class period, grade level and ability level of students, physical facility, teaching materials, supplies and other influences must be taken into consideration when designing the actual course to be taught.

Modules 1 and 2, "Introduction" and "Design/Problem Solving", are critical to the success of the course and should be included in any course structure. The remaining four modules may be included and/or emphasized according to the factors mentioned
above.

The content outlined in a number of modules is extensive and represents much more information than will actually be covered in most Introduction To Technology courses. It is presented here to put the concepts in perspective and provide the teacher with a resource for future course improvement and development of possible new courses in technology.

- 1.4.1.4 Contour Change
  - 1.4.1.4.1 Casting
  - 1.4.1.4.2 Forging
- 1.4.2 Material and Characteristics
  - 1.4.2.1 Materials
    - 1.4.2.1.1 Paper
    - 1.4.2.1.2 Card
    - 1.4.2.1.3 Plastics
    - 1.4.2.1.4 Clays
    - 1.4.2.1.5 Soft Wood
    - 1.4.2.1.6 Aluminum
  - 1.4.2.2 Characteristics
    - 1.4.2.2.1 Two-Dimensional
    - 1.4.2.2.2 Three-Dimensional

## MODULE 2.0 DESIGN / PROBLEM SOLVING

- **2.1 Design/Problem Solving Process**
  - 2.1.1 Identify the Problem
  - 2.1.2 Research Problem
  - 2.1.3 Define Limitations and Specifications
  - 2.1.4 Generate Alternative Solutions
  - 2.1.5 Select Optimum Solution
  - 2.1.6 Model or Construct Solution
  - 2.1.7 Evaluate Results
  - 2.1.8 Improvement/recommendations
- **2.2 Communication Skills**
  - 2.2.1 Sketching
  - 2.2.2 Perspective Drawing
    - 2.2.2.1 One Point
    - 2.2.2.2 Two Point
    - 2.2.2.3 Three Point
  - 2.2.3 Rendering
    - 2.2.3.1 Line
    - 2.2.3.2 Value
    - 2.2.3.3 Color
  - 2.2.4 Technical Drawing
  - 2.2.5 Computer-Aided Design and Drafting
  - 2.2.6 Copying (use of copyier)
  - 2.2.7 Typography
    - 2.2.7.1 Pressure Graphics
    - 2.2.7.2 Hand Lettering
    - 2.2.7.3 Computer-Generated Letters
  - 2.2.8 Graphing / Charting
  - 2.2.9 Writing
    - 2.2.9.1 Logs
    - 2.2.9.2 Reports
    - 2.2.9.3 Correspondence
    - 2.2.9.4 Proposal
    - 2.2.9.5 Persuasive (marketing)

- 2.2.10 Speaking
  - 2.2.10.1 Information Gathering
  - 2.2.10.2 Explaining
  - 2.2.10.3 Presenting
  - 2.2.10.4 Ideation

**2.3 Design**

- 2.3.1 Principles
  - 2.3.1.1 function
  - 2.3.1.2 aesthetics
  - 2.3.1.3 structure
  - 2.3.1.4 economy
  - 2.3.1.5 integrity
- 2.3.2 Elements
  - 2.3.2.1 Line
  - 2.3.2.2 Shape
  - 2.3.2.3 Form
  - 2.3.2.4 Value
  - 2.3.2.5 Color
  - 2.3.2.6 Texture

## MODULE 3.0 HISTORY/EVOLUTION OF TECHNOLOGY

**3.1 Development of Tools and Machines**

- 3.1.1 As extensions of human capabilities
- 3.1.2 Tool vs. Machine
- 3.1.3 Impacts on People

**3.2 Simple Machines**

- 3.2.1 First Recorded Use
- 3.2.2 Types

**3.3 Impacts of Technology on Civilization**

- 3.3.1 Group Living (towns/cities)
- 3.3.2 Transportation
- 3.3.3 Communication

**3.4 Selected Technological developments which changed the world**

- 3.4.1 Sail
- 3.4.2 Clock
- 3.4.3 Plough
- 3.4.4 Computer
- 3.4.5 Superconductor (?)

## MODULE 4.0 SYSTEMS OF TECHNOLOGY

- **4.1 Types of Systems**
  - 4.1.1 Natural
    - 4.1.1.1 Non-Biological
      - 4.1.1.1.1 Example: Hydrological Cycle
    - 4.1.1.2 Biological
      - 4.1.1.1.2 Example: Circulatory System
  - 4.1.2 Human
    - 4.1.2.1 Non-Technological
    - 4.1.2.2 Technological
- **4.2 Systems Utilize Resources**
  - 4.2.1 Tools/Machines
  - 4.2.2 Materials
  - 4.2.3 Information
  - 4.2.4 Energy
  - 4.2.5 Tools
  - 4.2.6 Processes
  - 4.2.7 Time
- **4.3 Systems Combine Resources in Processes**
  - 4.3.1 Processing Materials
  - 4.3.2 Processing Information
  - 4.3.3 Processing Energy
- **4.4 Systems Result in Outputs**
  - 4.4.1 Expected Desired
  - 4.4.2 Expected Undesired
  - 4.4.3 Unexpected Desired
  - 4.4.4 Unexpected Undesired
- **4.5 System Monitoring**
  - 4.5.1 Open-Loop (no monitoring)
  - 4.5.2 Closed-Loop
    - 4.5.2.1 Feedback
    - 4.5.2.2 Monitor
    - 4.5.2.3 Compare and Adjust
- **4.6 Other Impacts and Consequences**
  - 4.6.1 Personal Consequences
    - 4.6.1.1 Physical Effects
    - 4.6.1.2 Emotional Effects
    - 4.6.2 Social Consequences
    - 4.6.2.1 Environmental Effects
    - 4.6.2.2 Economic Effects

## MODULE 5.0 RESOURCES OF TECHNOLOGY

- **5.1 Tools/Machines**
  - 5.1.1 Extend Human Capabilities
  - 5.1.2 Basic Principles
  - 5.1.3 Subsystems of a Machine
    - 5.1.3.1 Support and Cover
    - 5.1.3.2 Power Transmission
    - 5.1.3.3 Guidance and Control
  - 5.1.4 Types of Machines
    - 5.1.4.1 Material Processing
    - 5.1.4.2 Information Processing
    - 5.1.4.3 Energy Processing
  - 5.1.5 Functions of Machines
- **5.2 Energy**
  - 5.2.1 Forms
    - 5.2.1.1 Heat (thermal)
    - 5.2.1.2 Light (radiant)
    - 5.2.1.3 Chemical
    - 5.2.1.4 Electrical
    - 5.2.1.5 Mechanical (motion)
    - 5.2.1.6 Nuclear
  - 5.2.2 Sources
    - 5.2.2.1 Non-Renewable
    - 5.2.2.2 Renewable
  - 5.2.3 Processing Energy
- **5.3 Information** ("Patterns of energy and/or materials intended to convey meaning")
  - 5.3.1 Elements
    - 5.3.1.1 Signals
    - 5.3.1.2 Symbols
    - 5.3.1.3 Codes
    - 5.3.1.4 Noise
    - 5.3.1.5 Entropy
  - 5.3.2 Signals
    - 5.3.2.1 Analog (continuous)
    - 5.3.2.2 Digital (discrete)
    - 5.3.2.3 Mixed
  - 5.3.3 Symbols
    - 5.3.3.1 Semantic
    - 5.3.3.2 Symbolic
    - 5.3.3.3 Figural
  - 5.3.4 Codes
    - 5.3.4.1 Meaning
    - 5.3.4.2 Efficiency
    - 5.3.4.3 Redundancy
  - 5.3.5 Processing Information
    - 5.3.5.1 Storing
    - 5.3.5.2 Categorizing / Classifying

**5.4 Materials**
- 5.4.1 Characteristics
  - 5.4.1.1 Physical
  - 5.4.1.2 Chemical
  - 5.4.1.3 Magnetic
  - 5.4.1.4 Electrical
  - 5.4.1.5 Thermal
- 5.4.2 Processing Materials
  - 5.4.2.1 Shape or Contour Change
  - 5.4.2.2 Separating
  - 5.4.3.3 Addition
  - 5.4.3.4 Internal Change

**5.5 Humans**
- 5.5.1 Producers
- 5.5.2 Distributors
- 5.5.3 Maintainers
- 5.5.4 Users

**5.6 Capital**

**5.7 Time**

**5.8 Resource Depletion**
- 5.8.1 Non-Renewable Resources
- 5.8.2 Renewable Resources

## MODULE 6.0 CONTROL TECHNOLOGY

- **6.1 Mechanical Movement**
  - 6.1.1 Linear (Translational)
    - 6.1.1.1 Distance
    - 6.1.1.2 Velocity
    - 6.1.1.3 Acceleration/Deceleration
    - 6.1.1.4 Reciprocation
  - 6.1.2 Rotory
    - 6.1.2.1 Rotational Velocity
    - 6.1.2.2 Acceleration/Deceleration
    - 6.1.2.3 Axis
    - 6.1.2.4 Cam Rotation
  - 6.1.3 Dynamics
    - 6.1.3.1 Force
    - 6.1.3.2 Mass
    - 6.1.3.3 Motion
    - 6.1.3.4 Acceleration/Deceleration
    - 6.1.3.5 Inertia
    - 6.1.3.6 Torque
    - 6.1.3.7 Centrifugal Force
  - 6.1.4 Springs and Elasticity
    - 6.1.4.1 Extension
    - 6.1.4.2 Contraction
    - 6.1.4.3 Distortion
    - 6.1.4.4 Force
  - 6.1.5 Friction and Lubricants
    - 6.1.5.1 Static
    - 6.1.5.2 Coulomb
    - 6.1.5.3 Viscous
    - 6.1.5.4 Friction Reduction
  - 6.1.6 Gears and Linkages
    - 6.1.6.1 Purposes
    - 6.1.6.2 Ratio
    - 6.1.6.3 Gear Trains
    - 6.1.6.4 Backlash
    - 6.1.6.5 Drive Gear
    - 6.1.6.6 Driven Gear
    - 6.1.6.7 Pitch
    - 6.1.6.8 Tooth
    - 6.1.6.9 Shafts
    - 6.1.6.10 Belts
    - 6.1.6.11 Gear Types
      - 6.1.6.11.1 Spur
      - 6.1.6.11.2 Bevel
      - 6.1.6.11.3 Helical
      - 6.1.6.11.4 Worm
      - 6.1.6.11.5 Differential

**6.2 Actuation**
- 6.2.1 Mechanical
  - 6.2.1.1 Gravity
  - 6.2.1.2 Springs
  - 6.2.1.3 Flywheels
  - 6.2.2 Electrical
  - 6.2.2.1 DC Motors
  - 6.2.2.2 AC Motors
  - 6.2.2.3 Stepping Motors
  - 6.2.2.4 Solenoids
- 6.2.3 Hydraulic
  - 6.2.3.1 Cylinders
  - 6.2.3.2 Motors
  - 6.2.3.3 Pumps
  - 6.2.3.4 Fluid
- 6.2.4 Pneumatic
  - 6.2.4.1 Cylinders
  - 6.2.4.2 Motors
  - 6.2.4.3 Compressors
  - 6.2.4.4 Air (Gas)

**6.3 Sensing**
- 6.3.1 Mechanical
  - 6.3.1.1 Temperature
  - 6.3.1.2 Movement
  - 6.3.1.3 Pressure
  - 6.3.1.4 Moisture
  - 6.3.1.5 Velocity
- 6.3.2 Electrical
  - 6.3.2.1 Temperature
  - 6.3.2.2 Movement
  - 6.3.2.3 Pressure
  - 6.3.2.4 Moisture
  - 6.3.2.5 Velocity
- 6.3.3 Hydraulic
  - 6.3.3.1 Temperature
  - 6.3.3.2 Movement
  - 6.3.3.3 Pressure
  - 6.3.3.4 Moisture
  - 6.3.3.5 Velocity
- 6.3.4 Pneumatic
  - 6.3.4.1 Temperature
  - 6.3.4.2 Movement
  - 6.3.4.3 Pressure
  - 6.3.4.4 Moisture
  - 6.3.4.5 Velocity

**6.4 Control Intelligence**
- 6.4.1 Open Loop Control
  - 6.4.1.1 Definition
  - 6.4.1.2 Mechanical
  - 6.4.1.3 Electrical
  - 6.4.1.4 Hydraulic
  - 6.4.1.5 Pneumatic

6.4.2 Closed Loop Control
- 6.4.1.1 Definition
- 6.4.1.2 Mechanical
- 6.4.1.3 Electrical
- 6.4.1.4 Hydraulic
- 6.4.1.5 Pneumatic

6.4.3 Regulation
- 6.4.3.1 Definition
- 6.4.3.2 Mechanical
  - 6.4.3.2.1 Friction Wheel
  - 6.4.3.2.2 Flywheel
  - 6.4.3.2.3 Governor
- 6.4.3.3 Electrical
  - 6.4.3.3.1 Resistors
  - 6.4.3.3.2 Capacitors
  - 6.4.3.3.3 Resistance/Capacitance
- 6.4.3.4 Hydraulic
  - 6.4.3.4.1 Flow Restriction
  - 6.4.3.4.2 Accumulators
  - 6.4.3.4.3 Pressure Regulators
- 6.4.3.5 Pneumatic
  - 6.4.3.5.1 Flow Restriction
  - 6.4.3.5.2 Accumulators
  - 6.4.3.5.3 Pressure Regulators

6.4.4 Real-Time Control
- 6.4.4.1 Definition
- 6.4.4.2 Response Time
- 6.4.4.3 Polling
- 6.4.4.4 Sampling

6.4.5 Amplifilcation
- 6.4.5.1 Gain
- 6.4.5.2 Velocity
- 6.4.5.3 Torque
- 6.4.5.4 Power
- 6.4.5.5 Voltage
- 6.4.5.6 Current
- 6.4.5.7 Wattage
- 6.4.5.8 Resonance
  - 6.4.5.8.1 Mechanical
  - 6.4.5.8.2 Electrical

6.4.6 Attenuation
- 6.4.6.1 Negative Gain
- 6.4.6.2 Velocity
- 6.4.6.3 Torque
- 6.4.6.4 Power
- 6.4.6.5 Voltage
- 6.4.6.6 Current
- 6.4.6.7 Wattage
- 6.4.6.8 Resonance
  - 6.4.6.8.1 Mechanical
  - 6.4.6.8.2 Electrical

6.4.7 Conversion
- 6.4.7.1 Mechanical Advantage
- 6.4.7.2 Transforming
- 6.4.7.3 Inversion
- 6.4.7.4 Type
  - 6.4.7.4.1 Rotory <-> Linear
  - 6.4.7.4.2 Rotory <-> Rotory
  - 6.4.7.4.3 Linear <-> Linear

**6.5 Combining Components to Create a System**

6.5.1 Mechanical Systems
- 6.5.1.1 Inputs
- 6.5.1.2 Processes
- 6.5.1.3 Outputs
- 6.5.1.4 Feedback

6.5.2 Electrical Systems
- 6.5.2.1 Inputs
- 6.5.2.2 Processes
- 6.5.2.3 Outputs
- 6.5.2.4 Feedback

6.5.3 Hydraulic Systems
- 6.5.2.1 Inputs
- 6.5.2.2 Processes
- 6.5.2.3 Outputs
- 6.5.2.4 Feedback

6.5.4 Pneumatic Systems
- 6.5.2.1 Inputs
- 6.5.2.2 Processes
- 6.5.2.3 Outputs
- 6.5.2.4 Feedback

6.5.5 Systems Within Systems
- 6.5.2.1 Inputs
- 6.5.2.2 Processes
- 6.5.2.3 Outputs
- 6.5.2.4 Feedback

**6.6 Cybernation and Automation**

6.6.1 Cybernetics
- 6.6.1.1 Definition
- 6.6.1.2 Intelligence
- 6.6.1.3 Self-Regulation
- 6.6.1.4 Techniques

6.6.2 Automation
- 6.6.2.1 Definition
- 6.6.2.2 Control
- 6.6.2.3 Timing
- 6.6.2.4 Sequencing
- 6.6.2.5 Initializing
- 6.6.2.6 Optimizing

6.6.3 Impacts
- 6.6.3.1 Work Place
- 6.6.3.2 Human Factors
- 6.6.3.3 Trade-offs
- 6.6.3.4 Determinations

## APPENDIX B:

# TECHNOLOGY LEARNING ACTIVITIES

The activities described in this section are meant to reinforce the objectives of the Introduction To Technology course. Many of the activities cut across several modules and are valuable examples of the interrelationships among the various aspects of technology. The teacher is encouraged to move activities from one module to another where appropriate and to modify them to the age and level of students, facilities, equipment and supplies available and the duration of the course. Activities are NOT sequenced or in any particular order of difficulty. Teachers and students should strive to develop their own problem solving activities around personal interests, the school and the community.

**IMPORTANT:**

Most of these activities can be enhanced by taking the developed devices to the next stage: that of product prototype. A higher degree of craftsmanship, adherence to the design principles, presentation drawings, packaging, etc., would result. It is not recommended that this be done in all cases as there would be time for only a few activities to be completed to this degree of sophisticaton.

An example of taking a product to the next stage is the pet feeder in activity M 6.11. The device which solves the problem may be constructed of wood, cardboard, acrylic, etc. and function to specifications but look quite rough. The same could be said for most commerical product operational models at this stage and most consumers would not purchase such a device with pulleys, gears, wires, levers, and all that visible. Once the device functions, however, it is natural to try and think of how it could be made from just one or two materials, how it could be simplified, made more attractive, and so on. Moving on to this next stage encourages careful choice of materials, the application of design princples to make a marketable product and may even provide an opportunity to develop advertizing and packaging for the product, showing the relationships among different areas of business, industry and technology.

## MODULE 1: INTRODUCTION TO TECHNOLOGY ACTIVITIES

### M 1.1 Tower Problem

Using only four sheets of 8 1/2" X 11" paper and 18" of transparent tape, design and construct a tower as high as possible. The tower must be free standing, i.e. it must not be fastened to the floor or table.

Materials provided - 4 sheets of 8 1/2" X 11" paper 18 inches of transparent tape

Equipment provided - 1 pair of scissors.

Concepts for integration in lessons and activity:
- compression
- shapes which resist compression forces
- specification, problem, design brief

### M 1.2 Bridge Problem #1

Design and build a bridge to span a one meter gap between two chairs. Rules: (1) The bridge must only rest on the chairs, it must not be fastened to them, (2) the bridge must be able to support at least 200 grams at its center but should be made as strong as possible, (3) the transparent tape must be used in pieces less than 10 cm long (20 pieces for the length provided).

Material provided - "construction" paper, string, 200 cm transparent tape

Equipment provided - Chairs, weights, scissors, a ruler.
This activity may be converted to english standard units but why not try it as a metric activity? **

Concepts for integration into lessons and activity:
- triangulation
- truss
- beam
- tension, compression
- deflection, bending
- load

### M 1.3 Bridge Problem #2

Design and build a bridge at least 3" wide to span 35 inches which will support 2 pounds suspended from the center. The bridge must not be fastened at either end.

Materials provided - 10, 1/4" X 1/4" square dowels 12" long; 2, 3" X 5" index cards, white glue

Equipment provided - glue gun (if time is a factor); or white glue; scissors; small fine-tooth saw; bench block for cutting. Once completed, the problem can be re-defined to have the bridge span 36". Now 3 of the 12" dowels will not span the distance so another design must be developed which utilizes the 10 dowels more economically. Either version of the problem could also be used alone.

Concepts for integration into lessons and activity:
- tension, compression
- deflection, bending
- load, gusset, truss

## M 1.4 Linear Measurement Concept

(material developed by R. Schneider, A. Lang, J. Orr and G. Sefcik)

Overview of Activity: Measurement has always played an important role in technology. The understanding of measurement is essential for technological as well as basic literacy. This activity demonstrates how measurement works through the development of an arbitrary linear unit and the application of that unit to the construction of a simple object.

Procedure:

1. Give each student a one-inch strip of construction paper of random length (from 8 to 18 inches long, all different).

2. Give following instructions to the class, demonstrating the first few steps.
   a. fold length in half, end to end;
   b. fold half length in half again to make four equal divisions;
   c. fold quarters again in half;
   d. and so on...
   e. stop folding when paper becomes too fat to fold.

3. Have students count the increments (areas between folds) and call the increments by the students first name.

   The entire length is called by the students last name

   Example: The measurement unit may be a johnson and it has been divided into 16 jills.

4. Show that by dividing something in half you get two parts, divide it in half again and you get four parts, in half again and you get eight parts, and so on...

5. Have students measure doorways, tables, etc. and record their results. Compare one students results with another and discuss why results differ. Compare english and metric measurements for the same objects. Make the point that all the units are abritrary but standardized. Discuss the meaning of "standardized". Show a metric measurement divided into 10 equal parts and how each of those parts may be divided into ten parts and discuss the differences between the two approaches (half of half of half... and base 10).

6. See if half increments (half jills) came up in any of the results. Ask if "because you have divided the johnson into 16 jills, there are 16 jills in a johnson?" (There are no set amount of jills, its just how far we have taken the divisions of the base unit of johnson). Get at the idea that the more divisions within the base unit, the higher the accuracy of measurement possible.

7. Have students try and find out what the inch is based upon for an out of class assignment.

8. Glue the measurement 'ruler' onto a stiff piece of card stock. Have students use it as a rule to construct a simple paper pencil box which will hold a dozen pencils.

## M 1.5 **Helping Hand** ***

Situation: People with rheumatism or arthritis in their fingers have great difficulty in gripping small items.

Brief: Design and make a device which will help one of these people to use a Yale type key more easily when opening a door. The device must be small enough to fit into a handbag or jacket pocket.

## M 1.6 **Musical Instrument** ***

Situation: You have probably made a musical sound by placing a wooden ruler so that it overhangs the edge of a table and then, with one hand pressing the ruler to the table top, you have vibrated it with the other hand. The note can be changed by varying the overhang. (An African instrument works on this same principle.)

Brief: Design and make a simple musical instrument based on the above principle. Experiment to obtain a good quality of tone and pitch. How can the resonance be amplified?

## M 1.7 **Hill Climber** ***

Situation: Model vehicle "hill climbing" can be a fun activity and construction is quite challenging.

Brief: Design and build a model vehicle which will climb an inclined surface using a small electric DC motor and 2 "D" cells. Record the maximum gradient which it will climb.

## M 1.8 **Bottle Cleaner** ***

Situation: The collection of old bottles is now a popular hobby. Cleaning the outside is easy, but cleaning the inside presents problems.

Brief: Design and make a cleaner for removing dirt from the inside of the bottle.

## M 1.9 **Bottle Cap Remover** ***

Situation: Elderly people and those who suffer from arthritis find great difficulty in opening bottlles, etc., which have screw-cap arrangements.

Brief: Design and make a device which will enable such people to remove lids, caps, etc., with ease.

## M 1.10 **Draw Bridge**

Brief: Design and build an operating model draw-bridge which demonstrates the princples of counter-weighting. The bridge should span 36" and be at least 4" wide. The bridge design should be engineered to avoid redundant members and have a pleasing appearance.

Materials: 1/4" X 1/4" square balsa or pine wood dowels; white glue; index card stock for gussets; 1/4" round dowels for axle shafts;

Further work: Design a way to operate the bridge with small DC electric motor(s); switching and reversing of motor(s)

## M 1.11 **Vertical Transport Mechanism**

Using Lego, Meccano or Fischertechnik kits, design and build a device which will transport a "D" size battery three feet vertically, and hold it there. The battery may be placed on to the device at the bottom of the three foot travel.

## MODULE 2: DESIGN / PROBLEM SOLVING ACTIVITIES

### M 2.1 Inertia Vehicle

Design and build a vehicle which will travel the maximum distance possible when released at the top of a six foot long ramp inclined at 15 degrees from the horizontal. The vehicle must travel by its own momentum.

Specifications
- -chassis must be constructed in the lab
- -wheels can be made from anything as long as they were not originally wheels: for example, wheels from roller skates cannot be used as wheels but jar lids can be used.
- -vehicle cannot be over 18 inches long

Documentation - Keep records of all sketches, drawings, diagrams, etc.; write down why you chose the final wheels in your design

Concepts for integration into lessons and activity:
- inertia
- rolling resistance
- friction
- flywheel
- documentation
- steps in design process

### M 2.1a Visual Instructions

Design Brief: Design a way of telling other people how to do something VISUALLY. The finished product should be either a presentation on a piece of poster board, or in booklet form.

examples: setting the time on a VCR; changing a tire; recording music from a record to a cassette; etc.

### M 2.1b Visual/Bilingual Instructions

Design Brief: Design a way of telling other people how to do something, both VISUALLY and in a language other than english ( such as spanish, german french, italian, russian, chinese, etc). The finished product should be either a presentation on a piece of poster board, or in booklet form.

### M 2.3 Activities for Design Principles

#### 2.3.1 Line

Situation: Many products use line in their desing to suggest an image for the product. Pin striping on classic cars and the linear slots and indentations which embellish appliances are examples.

Brief: Analyze a product which uses line and change the image by a different use of line.

### 2.3.2 Shape

Situation: The shape of a product can either hide or reveal its functioning. The classic levered corkscrew's form exactly depicts its function, while the wooden soldier nutcracker amuses and distracts.

Brief: Design a display of products which hide functioning and products which reveal functioning, using any of the following:

- sketches
- photos
- models
- actual products
- other simulations

### 2.3.3 Value

Situation: In presenting an idea to a client (or teacher or friend) it is important to be clear about each point you are trying to make. This can be done in sketching, writing, drawing through the use of emphasis. On the printed page, dark headings and italisized words stand out.

Brief: Try translating this principle of contrast to graphic emphasis. Sketch an existing product, reproduce it several times on a copier, and use value to emphasize different aspects of it in each version. Design a poster which communicates your message about the product.

### 2.3.4 Color

Situation: There are many considerations in packaging: packaging relies on color to appeal to different markets. The form of a well-designed package reflects function, appearance, elegance, economy and integrety (each of which is broken down to specification in the brief stage).

(a) Brief: Design a package for a regional product which will be marketed in a new area of the country:
Specifications:
- protective of product
- represents good image of region of origin
- can be made from one piece of cardboard and glue
- is economical
- is easily transportable, stockable
- attractive to consumers
- safe

(b) Brief: Present the package in 2 different color schemes with a rationale explaining the difference between the objectives and strategies for each scheme

### 2.3.5 Texture

Situation: Texture is not only decorative, it is also functional. Texture wall coverings may be chosen to lend warmth or interest to a room, but they may also have accoustic characteristics as well.

Brief: Visit a recreation center at school (or analyze a car or a kitchen), and identify as many designed textures as possible, designating them as functional or decorative and recording with sketches and notations.

## M 2.4 Fast Food Box

(material developed by Kjell-Jon Rye, Bellevue High School, Washington)

Brief: Design, build and market a container to hold fast food such as a hot dog, hamburger, burrito, breakfast sandwich or similar food.

Limitations :

1. Students will work in teams of two
2. Time limit will be two working days
3. One day will be used for evaluations
4. No copying of existing container designs
5. Use a minimum of three different materials
6. Use any material compatable with food
7. Package must have: a) company logo, b) company name, c) name of product

Evaluation: Students will judge marketing by ballots. Teacher will judge design of containers

Teacher Information:

This is an activity which teaches pattern layout, containment, marketing and appropriate use of materials.

The tech clud or some students in your class can organize abarbecue to fill the boxes with fast food. The product is thustested in a real world situation. An added benefit is that the students ge a free hamburger to eat. The tech club may sell the extra hamburgers during lunch as a fund raiser.

For product testing the food must sit in the container for two minutes before being eaten. Ask these questions of your students:

Experience any difficulty getting the food in or out?
Was there any structural change during use?
Did the box hold the heat?
Did the box give off any taste or smell when in use?
Can the container be stacked?
Was it economical and the appropriate use of materials?

- This is a fun way to get other students to look at your program because the barbecue smoke fills the school and it is the only topic of discussion by both students and staff.

## MODULE 3: HISTORY / EVOLUTION ACTIVITIES

### M 3.1 Sun Finder

Design and build a device which will accurately determine the altitude of the sun in degrees above the horizon.

Areas which must be addressed:

a. How will the horizon be determined?
b. How will the parts which sight the sun be located and adjusted for accuracy?
c. How will the sun be sighted without endangering the eye?
d. How will degrees be determined?

Concepts for integration into lessons and activity:

degree
altitude, azimuth
accuracy, tolerance
navigation
longitude, latitude

### M 3.2 Star Finder

Design and build a device which will accurately determine the altitude of a star in degrees above the horizon.

Areas which must be addressed:

a. How will the horizon be determined in the dark?
b. How will a star be sighted?
c. How will the angle between the horizon and the star be determined?

Concepts for integration into lessons and activity:

degree
accuracy, tolerance
magnitude
magnification
altitude, azimuth
level, plumb

### M 3.3 Old Log Cutter

Design and build a device which can cut through an eight inch log using only the materials and tools available in the 13th century.

Areas which must be addressed:

a. What materials and tools were available in the 13th century?

Concepts for integration into lessons and activity:

cutting, separating
iron, steel
medieval, middle ages, dark ages

## M 3.4 **Museum Display**

Design and make a display depicting the evolution of a particular technological device or tool. Assemble pictures, actual artifacts, descriptions, reprints of original patents, etc. into a museum-type display. Show progression from earliest instance to present day. Include future possible variations when appropriate. (Use student displays for "back-to-school night", showcase displays and/or traveling exhibits to elementary schools).

## M 3.5 **Water Wheel**

Design and make a working model of a historic water-powered wheel to 1/8" or to as much as 1" scale. Assign students different configurations such as over-shot, under-shot, vertical and horizontal shaft, etc. Introduce the use of jigs and fixtures when assembling the wheels. Try steam or hot water bending of the wheel timbers. Have students research as much as possible about their designs, such as where and when it appeared, what were the major uses for the power output (mill, hammer, pumping, etc.). Try to encourage as much realism as possible in the final models.

## M 3.6 **Time Line**

Place a strong string or wire across the room and have students bring in pictures or objects or make models of important inventions, scientific discoveries, pictures of great scientists and inventors, etc. and hang from wire. Make up signs of important or relevant dates (1492, 1066, etc) and hang where appropriate. Have students strive for neatness and quality presentation of ideas.

This idea can also be applied to a table-top exhibit using actual devices found in attics and basements of students and faculty. This is a good activity to have on display during a "back-to- school night."

## M 3.7 **Quill Pen**

Invesigate how quill pens were made. Construct one and write a one page description of how you went about it, using the pen.

## M 3.8 **Great Pyramid**

Obtain a geological survey map of grid where school is located. Using graph paper, and the same scale as the map, layout the great Pyramid of Cheops and transfer to map to get an idea of the size of the structure. Take students outside and layout pyramid according to points located on map, with two students standing at each corner (or use 5 foot poles with flags). Talk about how to get right angles for each corner and relate to 30-60-90 triangle. Discuss size and height of structure.

You may want to have several groups working on the same theme at once. Use: Stonehenge; the figures on the Nazca Plain (Peru); Colosseum (Rome); etc. Information on size of these structures is widely available.

## M 3.9 Simple Machines

### 3.9.1 The Pulley

Using Lego Meccano or Fischertechnik kits, design a pulley system which will provide a 3:1 mechanical advantage for lifting objects.

### 3.9.2 The Screw

Using Lego, Meccano or Fischertechnik kits, design and build a vertical lifting platform mechanism based on the screw.

### 3.9.3 The Lever

Using Lego, Meccano or Fischertechnik kits, design and build a crane using a third-class lever

## MODULE 4: SYSTEMS ACTIVITIES

### M 4.1 Burglar Alarm

Using switches, buzzer or bell and wire, design and build a device which will notify the class if someone attempts to enter the laboratory through a window. The device must be battery powered.

Concepts for integration into lessons and activity:
- -input, resources, processes, outputs
- -sensing
- -switching

### M 4.2 Energy Converter

Design and build a device which will convert flowing water (from a garden hose) to electrical energy. Measure the power output in watts.

Areas which must be addressed:
- a. Are there devices which can convert directly from moving water to electricity or will intermediate steps be necessary in the system.
- b. How can electricity be generated? Heat? Pressure? Motion? Others?
- c. How can electrical power be measured? What instruments are used?

Concepts for integration into lessons and activity:
- -flow rate (gallons per minute) and calculations
- -energy conversion
- -voltage and current
- -power - calculating watts
- -resistance
- -how to use meters to measure electrical properties
- -system - inputs, processes and outputs of the system
- -mechanisms - gearing, etc.

### M 4.3 Hydroponics

Brief: Design and build a device which will allow plants to grow indoors in a liquid-nutrient environment.

The activity can be individual (you will wind up with a lot of hydroponic gardens, but that can be good), or a small group project, or a single, larger hydroponic garden to which all students contribute. This activity demands student research and references should be available which deal with hydroponics. The lack of actual plans to follow will allow students to be more creative in their approaches to the problem. Look at stock materials, such as larger diameter PVC tubing, etc. for possible containers. Develop your own limitations and specifications.

This activity is excellent for the adaption of sensors and control to develop a closed-loop system which will maintain nutrient levels, pH levels, etc. It is an activity which can be done early in the school year, and improved and referred to during the course. Having fresh tomatos in January can be rewarding too.

## MODULE 5: RESOURCES OF TECHNOLOGY ACTIVITIES

### M 5.1 Solar-Powered Vehicle

Using 2 photovoltaic cells for an energy source, design and build a 10 inch long vehicle which will maintain the fastest speed on the school blacktop or parking lot area.

Areas which must be addressed:

a. Choice of DC motor which will work with 2 photovoltaic cells (about 1 volt when connected in series)
b. Rolling resistance of wheels over rough blacktop or parking lot
c. What are ways of minimizing the friction of the axles?
d. What is the best wheel diameter?

Concepts for integration into lessons and activity:

-photovoltaic cell operation
-solar energy
-DC polarity (reversing cell leads reverses the motor)
-torque
-voltage
-current
-power (calculate watts output of cells)

### M 5.2 Wind Measurement ***

Situation: Simple measuring devices can be made from waste materials and treaded as prototypes for better engineered devices.

Brief: Design a simple anemometer to measure the force of the wind and devise a means of measuring and timing the revolutions. You may find thread spools, dowel rod and milk cartons useful in your prototype.

### M 5.3 Paper Construction

(material developed by Kjell-Jon Rye, Bellevue High School, Bellevue, Washington)

These activities are good introductions to the principles of engineering design and material processing. You can start the unit by holding up a piece of paper and asking "What is this?" The response you want is (1) paper, which is the material, and (2) sheet, which is the form that the material is in. Then ask for other types of sheets, i.e.: sheet of plywood, sheet metal, sheet plastic, cloth sheets, etc. (all could be called 2-dimensional material).

You can lift up a piece of paper so it won't hold up its own weight and then ask class to describe the dynamics of the material in its present form. The answers will be "flimsy", "weak", etc., because it can't even hold its own weight. Then try to separate the paper by pulling it apart across its plane, which is very hard for a human to do, or have a student grab one end of it and drag her across the floor while she sits on a chair. Take a piece of paper and fold it down the middle so it forms a V shape and suddenly this sheet of paper will not only hold itself, but will also hold a pen or pencil.

The dynamics of sheet material have similarities such as high tensile strength and low compression strength. By modifying materials to take advantage of their properties, the engineer can build tall towers, strong structures and long bridges. The modification of materials is the base for most engineering related fields.

The next thing is to hold up tape, glue and staples and ask "What are these and what are they used for?" They are bonding agents and are used to bond materials together. In this unit we will be bonding similar materials together but we can also bond dis-similar materials. Ask for other ways to bond, i.e.: welding, nails, screws, sewing and lacing, etc.

Then hold up a pair of scissors or an xacto knife. These are parting tools, along with saws, cutting torch, water jets, laser scalpel, etc.

If your students manipulate this material and use these bonding agents and parting tools to their best advantage, then they will see how this knowledge transfers to building structures from other sheet materials, such as wood, steel, etc. While the tool skills differ, the princples of design do not.

### M 5.3.1 **Paper Tower**

Problem: Using one piece of paper and 10 cm of clear tape, construct a tower as high as you can.

Limitations: Time limit in construction is 30 minutes
Tower must be free standing
Tower can't be taped to floor or anything else
Tower must stand for 30 seconds during testing

### M 5.3.2 **Paper Foundation**

Problem: Using only one sheet of paper and white glue, construct a foundation which will support as much weight as possible.

Limitations: Time limit for construction is 30 minutes.
Foundation must be 10 cm tall (+/- 5 mm)
Foundation will be allowed to dry 23 hours

### M 5.3.3 **Paper Bridge**

Problem: Using only one sheet of paper and metal staples, build a bridge which will span the longest distance possible.

Limitations: Time limit for construction is 30 minutes
Bridge cannot be stapled down
Bridge must span the distance unsupported (carry its own weight)

## M 5.4 **It's About Time**

### 5.4.1 **Sun Clock**

Design and build a device which will allow the user to tell the time of day within one hour accuracy. The device should have some provision for adjusting to seasonal sun position (a simple sun dial will not do this). These devices reference the sun in the sky to estimate time. Introduce students to simple examples, such as the equatorial sundial before proceeding with the activity (Adzema's Sundial book is a very good source of information and examples).

### 5.4.2 **Water Clock**

Research medieval water clocks and design and build one type with the materials found in the laboratory. These devices measure the passage of time without outside reference.

### 5.4.3 **Escapement**

The development of the escapement mechanism revolutionized timekeeping. Using 2-dimensional modeling techniques, design and build an operational model escapement mechanism on a piece of homosote (or similar material).

More Difficult: Try building a 3-dimension working escapement mechanism from wood, plastic and or metal components

# MODULE 6: CONTROL TECHNOLOGY ACTIVITIES

## M 6.1 Timer

Design and build a device which will accurately register when 5 minutes have elapsed by a sound which can be heard at a distance of at least 20 feet. More Difficult: register when both 3 and 5 minutes have elapsed.

Areas which must be addressed:

a. How will the passing of time be measured?
b. What will be used to provide the audible tone or sound?

## M 6.2 Accurate Vehicle

Design and build a small vehicle which will travel exactly 20 feet.

Areas which must be addressed:

a. What form of energy system will power the vehicle?
b. How can the vehicle be designed to travel only a certain distance?

## M 6.3 Automatic Turning Vehicle

Design and build a small vehicle which will go straight for 20 feet, turn left 90 degrees, and go straight for 10 feet.

Areas which must be addressed:

a. What form of energy system will power the vehicle?
b. How can the vehicle be designed to go straight?
c. How can the vehicle be designed to make a remote 90 degree turn?
d. How can the vehicle be designed to travel only a certain distance?

## M 6.4 Door Sensor

Design and build a device which will count the number of people who enter or leave the laboratory in a day. The device must somehow register the count to be read as a total at the end of the school day.

Areas which must be addressed:

a. What form of sensing will be used to register the passage of a person through the door?
b. How will you keep track of the information from "a"?
c. How will you display totals?
d. Will it make a difference whether people are entering or leaving the room?

Concepts for integration into lessons and activity:

-sensing
-transducer
-analog, digital

### M 6.5 **Pick-Up Device** ***

Situation: Old and infirm people have difficulty in picking up fallen objects from the floor.

Brief: Design and make a hand held device which can be used to pick up items from the floor without the need to bend down.

### M 6.6 **Animated Toy** ***

Situation: A cam is used to change circular motion to vertical or horizontal motion.

Brief: Design a pull-along toy which makes use of the cam to obtain amusing movements.

### M 6.7 **Counter** ***

Situation: Many manufacturing processes require counting devices.

Brief: Design and make a device for counting the rotations of a bicycle wheel.

### M 6.8 **Moving Toy** ***

Situation: Moving toys will entertain a child for hours.

Brief: Design and make a toy which will climb up a one meter (or one yard) length of tightly stretched string.

### M 6.9 **Disco Lights** ***

Situation: At a disco four colored transparent sheets are to be rotated in front of a spotlight for effect.

Brief: Design a mechanism to rotate the disc so that it will stop at 90 degree intervals for 5 seconds before moving on to the next color.

### M 6.10 **Plant Waterer** ***

Situation: In hot weather, widow boxes are in need of frequent watering. Weekend travel is common, and the plants may need watering while no one is home.

Brief: Design and make a device that will water a flower box 24 hours after it has been set.

### M 6.11 **Pet Feeder**

Situation: When vacationing it is often a problem leaving fish or cats for several days when no one is around to feed them.

Brief: Design and build a device for either a cat or pet fish which will provide food for two days in both morning and evening (4 meals total).

## M 6.12 **Robot Gripper**

Design and build a robotic gripper from wood, plastic and/or metal which can be remotely controlled by hydraulics (syringes and water). Investigate the different kinds of grippers used on industrial robots before you begin developing your own designs. The gripper should be able to grasp both a "D" size battery and a sheet of paper.

## M 6.13 **Hitting the Target**

Using Lego, Meccano or Fischertechnik kits, design and build a device which will travel on a string suspended across the lab. The device must travel by its on-board power system and drop a sugar cube on a 2 foot diameter target on the floor near the middle of the room.

## M 6.14 **Sign Flasher**

Give some thought to how a marquis sign is caused to flash lights in sequence. Design a scheme to replicate this function.

## M 6.15 **Bumper Sensor**

Make a "bumper sensor" that will detect and indicate when a golf ball hits it.

## M 6.16 **Cam**

Design a cam that will allow a "square wave" to be drawn on a rotating drum.

## M 6.17 **Light Effects**

Using four cams, a motor and four micro-switches, design a device that will cause the bulbs to light up in a revolving sequence.

## M 6.18 **Smart Vehicle**

Design a vehicle that will follow a pre-determined pattern or course using a cam to control the steering.

## M 6.19 **Computer Control #1**

Write a program to sequence four lights (outputs) in a revolving sequence.

## M 6.20 **Computer Control #2**

Design a vehicle using DC motors to be controlled through an interface by the outputs of a computer.

## M. 6.21 **Computer Control #3**

Devise a scheme to simulate the cycles of a washing machine doing a load of wash

## M 6.22 **Computer Control #4**

Design a system to detect the interruption of a light beam.

## M 6.23 **Computer Control #5**

Construct a weather station in which the data is logged by a computer.

## M 6.24 **Balancing Act**

Design and construct a system that will indicate when a platform becomes unbalanced.

** Activities adapted from More Ideas for Egg Races: and other practical problem solving activities. British Association for the Advancement of Science, 23 Savile Row, London W1X 1AB, England.

*** Activities adapted from "Problem Solving Approaches" Staffordshire Summer School, 1982. and "Craft, Design and Technology in the Middle Years of Education (8-13 yrs)" Staffordshire L. E. A. 1981.

## APPENDIX C:

# EVALUATION INSTRUMENT FOR TECHNOLOGY ACTIVITIES

The following evalution instrument was adapted from the Oxford and Cambridge 'O' Level examinations in Technology used in England. It is a useful form as it provides emphasis on "process" as well as "product". The original form was intended to be applied to comprehensive design/problem solving activities in technology, often taking one or two years to complete.

The form developed here is intended to be applied to more modest projects but the emphasis remains on process as well as product and on the design/problem solving process. The one-page form is intended for one student and allows the instructor to track the progress of that student and identify areas in need of improvement. The form may be copied so that the teacher has the same number of forms as number of students.

The form should be introduced to the students as soon as the teacher has covered the design/problem solving process. The assessment used to determine grades is important for the student to understand early in the course. Periodically, the teacher should go over each student's progress with that student so attention can be given to areas of need.

| Bucky Fuller | 4 | Balloon vehicle | Clock chamber | Gravity alarm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|

**DOCUMENTATION** (60 points)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BRIEF / SPECIFICATIONS** (10pts) | | | | | | | | | | | | |
| (A) | No brief or specifications | 0 | | | | | | | | | | |
| (B) | Brief included, no specifications | 5 | | | | | | | | | | |
| (C) | Brief and specifications included | 10 | 10 | 10 | 5 | | | | | | | |
| **INVESTIGATION AND RESEARCH** (10pts) | | | | | | | | | | | | |
| (A) | No evidence of investigation or research | 0 | | | | | | | | | | |
| (B) | Some research with evidence of reading about the problem but lacking depth | 5 | | | | | | | | | | |
| (C) | Evidence of good research and that student has acquired new knowledge about the nature of the problem and what others have done to solve similar problems | 10 | 10 | 10 | 8 | | | | | | | |
| **SOLUTIONS** (10 pts) | | | | | | | | | | | | |
| (A) | Only one solution considered | 0 | | | | | | | | | | |
| (B) | Two solutions generated, only one seriously considered | 3 | | | | | | | | | | |
| (C) | At least three solutions generated but reasons for rejecting alternatives unclear | 5 | | | | | | | | | | |
| (D) | At least three solutions generated and two seriously considered with reasons stated for rejecting alternatives | 8 | 8 | 10 | 10 | | | | | | | |
| (E) | At least four solutions generated and three solutions seriously considered. Good reasons for rejected alternatives clearly stated. | 10 | | | | | | | | | | |
| **PROJECT TESTING** (10pts) | | | | | | | | | | | | |
| (A) | Project not tested | 0 | | | | | | | | | | |
| (B) | Project tested but no presentation of results | 4 | | | | | | | | | | |
| (C) | Project tested with weak presentation of results | 7 | | | | | | | | | | |
| (D) | Project tested with good presentation of results | 10 | 10 | 10 | 10 | | | | | | | |
| **EVALUATION** (10pts) | | | | | | | | | | | | |
| (A) | No evaluation written | 0 | | | | | | | | | | |
| (B) | Poor evaluation with little thought or intelligent comment or containing unjustified self-congratuation | 2 | | | | | | | | | | |
| (C) | An evaluation with no self-criticism and little insight | 4 | | | | | | | | | | |
| (D) | Good evaluation including self-criticism where appropriate. Possible suggestions about alternatives which, if followed, could lead to improvements to project | 8 | 8 | 8 | 10 | | | | | | | |
| (E) | Good evaluation including self-criticism where appropriate. Detailed reasons given for the success of the project OR details given of the modifications or alterations which would ensure a successful conclusion | 10 | | | | | | | | | | |
| **OVERALL PRESENTATION** (10pts) | | | | | | | | | | | | |
| (A) | No documentation of work | 0 | | | | | | | | | | |
| (B) | Limited documentation but little illustrative material. Not well organized or presented. Not very neat. | 4 | | | | | | | | | | |
| (C) | Documented with some illustrative materials. An attempt at organization and reasonably neat in appearance | 7 | 7 | 8 | 10 | | | | | | | |
| (D) | Good documentation with good use of illustrative materials. Well organized and neat | 10 | | | | | | | | | | |
| **PROJECT** (40 points) | | | | | | | | | | | | |
| (A) | Very poor work, no evidence of craftsmanship or no evidence of any work | 0 | | | | | | | | | | |
| (B) | Generally poor work with little craftsmanship shown | 8 | | | | | | | | | | |
| (C) | An average amount of work completed but with little care or craftsmanship shown | 16 | | | | | | | | | | |
| (D) | Average amount of work with several examples of attention to detail | 24 | | | | | | | | | | |
| (E) | Good quality work including realistic choice and use of materials where appropriate. Room for some improvement | 32 | 32 | 38 | 32 | | | | | | | |
| (F) | Evidence of thorough work appropriate to time allotted. Construction completed with attention to detail | 40 | | | | | | | | | | |
| | TOTALS | | 85 | 94 | 85 | | | | | | | |

Bucky Fuller | Intro. to Technology | Mon - Thurs. P.4 | Sp. 88

**DOCUMENTATION** (60 points)

**BRIEF / SPECIFICATIONS** (10pts)

| | | |
|---|---|---|
| (A) | No brief or specifications | 0 |
| (B) | Brief included, no specifications | 5 |
| (C) | Brief and specifications included | 10 |

**INVESTIGATION AND RESEARCH** (10pts)

| | | |
|---|---|---|
| (A) | No evidence of investigation or research | 0 |
| (B) | Some research with evidence of reading about the problem but lacking depth | 5 |
| (C) | Evidence of good research and that student has acquired new knowledge about the nature of the problem and what others have done to solve similar problems | 10 |

**SOLUTIONS** (10 pts)

| | | |
|---|---|---|
| (A) | Only one solution considered | 0 |
| (B) | Two solutions generated, only one seriously considered | 3 |
| (C) | At least three solutions generated but reasons for rejecting alternatives unclear | 5 |
| (D) | At least three solutions generated and two seriously considered with reasons stated for rejecting alternatives | 8 |
| (E) | At least four solutions generated and three solutions seriously considered. Good reasons for rejected alternatives clearly stated. | 10 |

**PROJECT TESTING** (10pts)

| | | |
|---|---|---|
| (A) | Project not tested | 0 |
| (B) | Project tested but no presentation of results | 4 |
| (C) | Project tested with weak presentation of results | 7 |
| (D) | Project tested with good presentation of results | 10 |

**EVALUATION** (10pts)

| | | |
|---|---|---|
| (A) | No evaluation written | 0 |
| (B) | Poor evaluation with little thought or intelligent comment or containing unjustified self-congratulation | 2 |
| (C) | An evaluation with no self-criticism and little insight | 4 |
| (D) | Good evaluation including self-criticism where appropriate. Possible suggestions about alternatives which, if followed, could lead to improvements to project | 8 |
| (E) | Good evaluation including self-criticism where appropriate. Detailed reasons given for the success of the project OR details given of the modifications or alterations which would ensure a successful conclusion | 10 |

**OVERALL PRESENTATION** (10pts)

| | | |
|---|---|---|
| (A) | No documentation of work | 0 |
| (B) | Limited documentation but little illustrative material. Not well organized or presented. Not very neat. | 4 |
| (C) | Documented with some illustrative materials. An attempt at organization and reasonably neat in appearance | 7 |
| (D) | Good documentation with good use of illustrative materials. Well organized and neat | 10 |

**PROJECT** (40 points)

| | | |
|---|---|---|
| (A) | Very poor work, no evidence of craftsmanship or no evidence of any work | 0 |
| (B) | Generally poor work with little craftsmanship shown | 8 |
| (C) | An average amount of work completed but with little care or craftsmanship shown | 16 |
| (D) | Average amount of work with several examples of attention to detail | 24 |
| (E) | Good quality work including realistic choice and use of materials where appropriate. Room for some improvement | 32 |
| (F) | Evidence of thorough work appropriate to time allotted. Construction completed with attention to detail | 40 |

TOTALS

## APPENDIX D:

### Tools and Supplies for Introduction to Technology

**Tools and Equipment:** minimum needed to teach course (suggestions are for 18 students)

| Description | Suggested Quantity |
|---|---|
| Electric Hand Drill 3/8" or 1/2" | 2 |
| Hot Glue Gun | 6 |
| 100 Watt Soldering Gun | 1 |
| 25 Watt Soldering Iron | 3 |
| Power Sabre Saw | 1 |
| Electric Palm Sander | 2 |
| Hand Drill | 4 |
| Combination Square | 12 |
| Sliding T-Bevel | 2 |
| Screwdrivers | assorted |
| Allen wrenches | assorted |
| Files | assorted |
| "Dremel"-type grinder | 1 |
| Portable DC Power Supplies- variable 0-12VDC @ 5A | 4 |
| Scribe | 4 |
| Meter sticks | 6 |
| Rulers, 24" | 6 |
| Rulers, 18" | 6 |
| Rulers, 12" | 6 |
| Tape measure, 8' | 6 |
| Tape measure, 25' | 2 |
| Handsaws | assorted |
| Scissors | 12 pair |
| Exacto Knives | 12 |
| Utility Knives | 6 |
| "Letra-Jet" type air-brush | 2 |
| Construction Kits (Leggo, Fischertechnik, Meccano, etc) | |
| Sewing Machine (used) | 1 |
| Bandsaw | 1 |
| Drill Press | 1 |
| Clamps | assorted |
| Computer | 1 or more |
| Camera - 35mm | 1 |
| Paper Cutter | 1 |
| Strip Heater | 1 |

**Supplies:** (Needed to do problem solving activities)

---

Sheet materials:
- plastic, acrylic; vinyl
- metal, aluminum; steel
- poster board
- paper
- mat board
- foam-core board; 1/8", 1/4". 1/2"
- fabric, canvas

Solid materials:
- wood
- metal
- plastic
- wax
- plasicine
- clay

OTHER ASSORTED MATERIALS AND SUPPLIES:

plastic tubing, clear flexible: 3/16" to 3/8"
wooden dowels: 1/8" to 3/4"
plastic water pipe: (PVC) 3/8" to 4"
gears: assorted, bevel, spur, worm, helical, etc, for shaft diameters 1/8" to 1/4"
welding rod: (axles for above) 1/8" to 1/4"
rubber bands: assorted
hot glue sticks
machine nuts, bolts, washers: assorted, 4-40 - 1/4-20
wood screws: assorted sizes and lengths
pan head sheet metal screws: assorted sizes and lengths
duct tape
hex head bolts and nuts: assorted sizes and lengths
carriage bolts: assorted sizes and lengths
nails: common and finishing, assorted sizes
pins
white glue
resin glue
epoxy glue
velcro strips: hook and loop
abrasive paper
xacto blades
utility knife blades
thread
needles
paper straws
marker sets
paint
brushes
wood wheels
springs
rope

press type
hose clamps, assorted
wire staples
syringes, 30cc; 10cc; 5cc; 3cc; 1cc

ELECTRICAL SUPPLIES:

batteries: assorted sizes and voltages
battery holders: assorted
solder: solid core and resin core
electrical wire: plastic insulated, 22-14 gauge
electrical wire: varnish insulated, 32-14 gauge
electrical cable: 2 conductor speaker wire
power transistors, 3055
relays, DPDT, 5 volt and 12 volt
switches, toggle DPDT
soldering paste
electrical tape
DC electric motors: assorted, 1.5 to 12 volts DC

## APPENDIX E:

### Materials for Technology Resource Center

List of resource materials for technology education programs:
(No endorsement of any product or publication is implied)

## BOOKS:


Adzema, R. and Jones, M. **The Great Sundial Cutout Book**. Hawthorn Books, Inc. 1978. ISBN 0-8015-3117-9

Allen, E. **How Building Work.** Oxford University Press. 1980. ISBN 0-19-502605-5

**ARRL 1986 Handbook for the Radio Amateur.** American Radio Relay League. 1986. ISBN 0-87259-162-X

Asimov, I. **Asimov's New Guide to Science.** Viking Press. 1985. ISBN 0-670-80347-2

Asimov, I. **Your World 2000: Technology.** Facts on File Publications. 1985. ISBN 0-8160-1155-9

Berger, P. **The State-of-the-Art Robot Catalog.** Dodd, Mead & Company. 1984. ISBN 0-396-08361-7

Berlin, H. **The Illustrated Electronics Dictionary.** Charles E. Merrill Publishing Company. 1986. ISBN 0-675-20451-8

Butti, K. and Perlin, J. **A Golden Thread: 2500 Years of Solar Architecture and Technology.** Van Nostrand Reinhold Company. 1980. ISBN 0-442-24005-8

Calder, N. **Timescale: An Atlas of the Fourth Dimension.** Viking Press. 1983. ISBN 0-670-71571-9

Caney, S. **Steve Caney's Invention Book.** Workman Publishing. 1985. ISBN 0-89480-076-0

Cetron, M. **Jobs of the Future: The 500 Best Jobs- Where They'll Be and How to Get Them.** McGraw-Hill Book Company. 1984. ISBN 0-07-010342-9

Cipolla, C. & Birdsall, D. **The Technology of Man.** Holt, Rinehart and Winston. 1979. ISBN 0-03-057792-6

Cooper, C. & Osmond, T. **How Everyday Things Work.** Facts On File Publications. 1984. ISBN 0-87196-988-2

De Old, A., Sheets, E. & Alexander, W. **Transportation: The Technology of Moving People and Products.** Davis Publications. 1986. ISBN 0-87192-172-3

Fuller, R. Buckminster. **Inventions: The Patented Works of R. Buckminster Fuller.** St. Martin's Press. 1983. ISBN 0-312-43477-4

Gatland, K. **The Illustrated Encyclopedia of Space Technology.** Harmony Books. 1981. ISBN 0-517-542587

Goetsch, D. and Nelson, J. **Technology And You.** Delmar Publishers, Inc. 1987. ISBN 0-8273-2662-9

Hacker, M. and Barden, R. **Technology In Your World.** Delmar Publishers, Inc. 1987. ISBN 0-8273-2655-6

**Henley's 20th Century Book of 10,000 Recipes, Formulas and Processes.** Embassy Sales, Dept PS 79, Box 67, East Elmhurst, NY 11369 ($18.90)

**Inside Modern Technology: How it Works.** Greenwich House. 1982. ISBN 0-517-38530-9

Johnson, B. **Optics and Optical Instruments.** Dover Publications. 1960. ISBN 0-486-60642-2

Johnson, J. **A Look Inside Lasers.** Raintree Publishers. 1981. ISBN 0-8172-1400-3

Lambert, D. & Osmond, T. **Great Discoveries and Inventions.** Facts on File Publications. 1985. ISBN 0-8160-1062-5

Lesko, Matthew. **Lesko's New Tech Sourcebook.** Harper & Row Publishers. 1986. ISBN 0-06-181509-8

Lister, G. **Technology Activity Guide 1.** Delmar Publishers. 1987. ISBN 0-8273-2739-0

MaCaulay, D. **Castle.** Houghton Mifflin Company. 1977. ISBN 0-395- 25784-0

MaCaulay, D. **Cathedral.** Houghton Mifflin Company. 1973. ISBN 0-395-17513-5

MaCaulay, D. **City.** Houghton Mifflin Company. 1974. ISBN 0-395-19492-7

MaCaulay, D. **Pyramid.** Houghton Mifflin Company. 1975. ISBN 0-395-21407-6

McCormack, A. **Inventors Workshop.** David S. Lake Publishers. 1981. ISBN 0-8224-9783-2

McGown, L. & O'M. Bockris, J. **How to Obtain Abundant Clean Energy.** Plenum Press. 1980. ISBN 0-306-40399-4

**McGraw-Hill Concise Encyclopedia of Science and Technology.** McGraw-Hill Book Company. 1985. ISBN 0-07-045482-5

**McGraw-Hill Dictionary of Science and Engineering.** McGraw-Hill Book Company. 1985. ISBN 0-07-045483-3

**McGraw-Hill Dictionary of Scientific and Technical Terms.** 3rd edition. McGraw-Hill Book Company. 1984. ISBN 0-07-045269-5

Micklus, S. **Odyssey of the Mind.** Creative Publications, Inc. 1984. (P.O. Box 27, Glassboro, NJ 08028)

**Modular Courses in Technology**: Series of 8 books, workbooks and teachers guides. Oliver & Boyd.
- **Electronics** ISBN 0-05-003383-2
- **Energy Resources** ISBN 0-05-003380-8
- **Instrumentation** ISBN 0-05-003544-4
- **Materials Technology** ISBN 0-05-003395-6
- **Mechanisms** ISBN 0-05-003386-7
- **Problem Solving** ISBN 0-05-003392-1

**Pneumatics** ISBN 0-05-003535-5
**Structures** ISBN 0-05-003389-1

The above are available from Creative Learning Systems, Inc.

Naisbitt, J. **Megatrends.** Warner Books. 1984. ISBN 0-446-90991-2

Nicholls, R. **Hydroponics Soiless Gardening.** Running Press. 1977. ISBN 0-89471-008-7

Potter, T. **How to Make Computer-Controlled Robots.** Usborne. (EDC Publishing, 8141 E. 44th St., Tulsa, OK 74145. ISBN 086020-815-X

Resh, H. **Hydroponic Food Production.** Woodbridge Press Publishing Co. 1985. ISBN 0-88007-154-0

Ruedisili, L. & Firebaugh, M. **Perspectives on Energy.** 3rd Edition. Oxford University Press. 1982. ISBN 0-19-503038-9

Seymour, J. **The Forgotten Crafts.** Alfred A. Knopf. 1984. ISBN 0-394-53956-7

Sheffield, C. & Rosin, C. **Space Careers.** Quill. 1984. ISBN 0-688-03256-7

Stanish, B. **The Unconventional Invention Book.** Good Apple, Inc. 1981. ISBN0-86653-035-5

Strandh, S. **A History of the Machine.** A & W Publishers, Inc. 1979. ISBN 0-89479--25-0

Stine, G. H. **Handbook of Model Rocketry.** Arco Publishing, Inc. 1983. ISBN 0-668-05360-7

Taylor, P. **The Kids' Whole Future Catalog.** Random House. 1982. ISBN 0-394-85090-4

Todd, R., McCrory, D & Todd, K. **Understanding and Using Technology.** Davis Publications. 1985. ISBN 0-87192-165-0

Toffler, A. **The Third Wave.** Bantan Books. 1980. ISBN 0-553-22635-5

Unterseher, F. et al. **Holography Handbook.** Ross Books. 1982. ISBN 0-89496-017-2

Walker, L. & Milstein, J. **Designing Houses.** The Overlook Press. 1979. ISBN 0-87951-096-X

Watts, L. & Wharton, M. **Machine Code for Beginners.** Usborne Publishing Ltd. 1983. ISBN 0-86020-735-8

Wulffson, D. **The Invention of Ordinary Things.** Lothrop, Lee & Shepard Books. 1981. ISBN 0-688-41978-X

Zubrowski, B. **Drinking Straw Construction.** Little, Brown and Company. 1981. ISBN 0-316-98875-8

## MAGAZINES:

Discover. Time, Inc., Time and Life Bldg., Rockefeller Center, New York, NY 10020-1393 ($24/yr)

Futurist. Journal of the World Future Society, 4916 St Elmo Avenue, Bethesda, MD 20814-9968 ($25/yr)

Popular Science. Box 2871, Boulder, CO 80322 ($8/y-r)

Robotics Age. Robotics Publications, PO Box 358, Peterborough, NH 03458 ($21/yr)

Scientific American. P.O. Box 5969, New York, NY 10017 ($24/yr)

TIES. (Technology, Innovation and Entrepreneursip for Students) new magazine for technology education out of Drexel University. Watch for premier issue winter of 1987-88

Various computer magazines
Various electronics magazines
Various how-to magazines

## VIDEOS/FILMS:

**Connections.** (series of 10 videos @ 50 minutes each) BBC and Time-Life Television. educational kit available from: Connections Educational Materials, AT & T College Relations, 195 Broadway, Room 540A, New York, NY 10007. Connections series videos available from: Time-Life Multimedia, Rm 32-48, Time & Life Building, NY, NY 10020.

**The Day the Universe Changed.** (series of 8 videos @ 50 minutes each) BBC. Presently on PBS channels. Deals with the discovery of new knowledge or new ways of doing things that drastically changed the way people looked at the world. Especially good episodes dealing with the printed word and the industrial revolution.

**Miraculous Machines.** (70 minutes) National Geographic Film. A look at the computer and its growing impact on almost every facet of our lives from production to helping the disabled to walk.

**Energy: The Fuels and Man.** (23 minutes) National Geographic Film. Shows development of energy sources from domesticated animals to nuclear power. Good introduction to the study of energy. A teachers guide can be obtained from the National Geographic Society, 17th and M Streets N.W., Washington, DC 20036.

**Energy: The Problems and the Future.** (23 minutes) National Geographic Film. Addresses the question of how is the energy-dependent world going to function when its non-renewable fuels are exhausted. Demonstration of passive solar heated homes, geothermal energy use in Italy and Oregon, ocean thermal energy conversion and wind energy conversion. A teachers guide can be obtained from the National Geographic Society, 17th and M Streets N.W., Washington, DC 20036.

**Toast.** (10 minutes) Bullfrog Films. With no narration, this film looks at the resources and processes which go into producing one piece of toast. Excellent for starting discussions on resources and energy.

**The Energy Carol.** (10 minutes) National Film Board of Canada, 1251 Avenue of the Americas, 16th Floor, New York, NY 10020

**Bill Loosley's Heat Pump.** (10 minutes) Bullfrog Films. Bill Loosley lives in Ontario and has heated his home for over 25 years with a heat pump of his own design--for about $75/year! Simple explanation of the workings of heat pumps.

**Pedal Power.** (15 minutes) Bullfrog Films. A look at the human resource of muscle power and some practical applications. A history of pedal power from da Vinci to the modern bicycle. Good for developing interest in practical projects.

**100 Watts, 120 Volts.** (6 minutes) Films Incorporated. A look at the making of alight bulb, this award winning video is an excellent introduction to a discussion of technology in our world.

**Goodbye Gutenberg.** (90 minutes) Films Incorporated. Examines the development and future of both the printed and processed word.

**Computers in Control.** (5 programs @ 20 minutes each) Films Incorporated.
1) Introducing The Robot; 2) Making Sense Of The Real World; 3) Making Things Move; 4) Getting It Together; 5) Recognizing The Obvious. Excelent series produced by the BBC (1984) demonstrating how microcomputers can be used in a variety of control applications. Will make sense to those with little or no computer knowledge. Shows applications from industrial and 'cutting edge' technology to classroom applications using Fischertechnik.

**Painting by Numbers.** (60 minutes) Films Incorported. The world of computer graphics.

**You, Me and Technology.** (series of 6 videos @ 30 minutes each)

## SOURCES OF BOOKS, MEDIA AND TEACHING SUPPLIES FOR INTRODUCTION TO TECHNOLOGY:

Write for catalogues: (no endorsement of any supplier or company is implied)

**Alpha Suppy Company**
248 Route 181
Lake Hopatcong, NJ 07849

multibotics- inexpensive robotic teaching tools for several popular computers

**Bullfrog Films**
Oley, PA 19547

films on alternative energy, conservation and related topics

**Creative Learning Systems, Inc.**
9889 Hibert, Suite E
San Diego, CA 92131

reference books, software, Fischertechnik, Meccano and other technology education supplies

**Edmund Scientific**
101 E. Gloucester Pike
Barrington, NJ 08007

lenses, electric motors and a wide variety of materials for technology activities

**Films Incorporated**
5547 N. Ravenswood Ave.
Chicago, IL 60640-1199

VHS videos on technology, science and contemporary issues

**The Futurist Bookstore**
World Future Society
4916 St. Elmo Avenue
Bethesda, MD 20814

future oriented books and media dealing with technology, education, occupations, etc.

**National Geographic Society**
Educational Services
Department 87
Washington, DC 20036

films and videos on a variety of technology and science related areas

**PBS Video**
1320 Braddock Place
Alexandria, VA 22314-1698

videos on a variety of technology-related subjects; impacts of technology, etc.

**Pitsco**
PO Box 1328
Pittsburg, KS 66762

syringes & plastic tubing for hydraulics; plastic gears, wheels, etc.

## APPENDIX F: COURSE PLANNING WORKSHEET

# COURSE PLANNING WORKSHEET

COURSE TITLE: **Introduction To Technology**
SCHOOL: _____ INSTRUCTOR: _____
COURSE DURATION: _____ weeks
GRADE LEVEL(S) OF STUDENTS: _____

---

(1) Choose modules to be covered during course.

| | Included? | Priority= high | medium | low |
|---|---|---|---|---|
| Module 1: Introduction | yes | x | | |
| Module 2: Design/Problem Solving | yes | x | | |
| Module 3: History/Evolution | | | | |
| Module 4: Systems | | | | |
| Module 5: Resources | | | | |
| Module 6: Control | | | | |

(2) Determine relative emphasis of modules; include approximate number of weeks per module.

course begins — course ends

TIME LINE (____ weeks)

(3) Develop lesson list and choose major activites for modules.

MODULE 1: INTRODUCTION TO TECHNOLOGY

| Lesson Titles | Emphasis |
|---|---|

| Major Activites | Time Allotted (periods) |
|---|---|

(4) Develop lesson list and choose major activites for remaining modules.

MODULE __: _____

Lesson Titles Emphasis

Major Activites Time Allotted (periods)

---

MODULE __: _____

Lesson Titles Emphasis

Major Activites Time Allotted (periods)

MODULE __: _____

Lesson Titles | Emphasis

Major Activites | Time Allotted (periods)

---

MODULE __: _____

Lesson Titles | Emphasis

Major Activites | Time Allotted (periods)

## APPENDIX G:

### Pre-Post Test: Technology Interest and Assessment Instrument

The questionnaire on the following pages was developed in the Netherlands to assess students' interest in technology. Used as a pre-post test evaluation, it may provide feedback to the teacher about attitude changes which may have occurred as a result of the **Introduction To Technology** course.

The Commission on Technology Education for the State of New Jersey would be very interested in the results of any pre-post test analysis using this technology attitude assessment instrument. Send results to: The Commission on Technology Education for the State of New Jersey, c/o NJ Bell, 6000 Hadley Road, So. Plainfield, NJ 07080.

### Technology Questionnaire - instructions for Administration

1. Read through page 2 aloud to explain how to respond to the questionnaire. If students wish to change their answer, put an 'X' through (or erase) the wrong response and circle the correct response.
   e.g.
   1 2 3 4 5

2. Page 3 - have students fill this in as you go through it

3. Page 4 - questions begin
   Students might like to run a ruler down the page so that they circle the correct line of numbers.

4. If students do not know what technology is, **do not** tell them! Ask them to answer all the items as best they can, and for the items they can not or do not understand, circle item 3 for undecided.

5. When students have finished, please ask them to check they have answered all the questions. It is easy to miss a page or answer two questions on the same line.

## QUESTIONNAIRE ABOUT TECHNOLOGY

In the newspapers you often read things about technology. You can also watch may TV programs about technology.

In this questionnaire we want to ask you about your opinion of technology. Please, answer the questions and let us know what you think of technology.

This questionnaire contains 78 statements. You should indicate whether you agree or not.

An example:

| | strongly agree | agree | un-decided | dis-agree | strongly disagree |
|---|---|---|---|---|---|
| Mathematics is very interesting. | 1 | 2 | 3 | 4 | 5 |

---

If you strongly agree, put a circle around answer 1 (like this: 1 )

If you agree, but you hesitate, put a circle around answer 2 ( 2 )

If you are undecided, put a circle around answer 3 ( 3 )

If you disagree, but you hesitate, put a circle around answer 4 ( 4 )

If you strongly disagree, put a circle around answer 5 ( 5 )

---

GIVE YOUR OWN OPINION

DON'T THINK TOO LONG ABOUT A STATEMENT

THE RESULTS ARE WORKED OUT ANONYMOUSLY; YOU DON'T HAVE TO GIVE YOUR NAME

IT IS IMPORTANT TO ANSWER ALL QUESTIONS ON PAGE 3

Thank you very much for your help!

PLEASE, ANSWER THESE QUESTIONS FIRST:

What is your age (in years)? _____

Write down whether you are a girl or a boy _____

Describe the occupation of your father (what he does, where he works).

_____

_____

_____

_____

Do the same in respect to your mother.

_____

_____

_____

_____

ON THE NEXT PAGE THE STATEMENTS BEGIN.

| | | strongly agree | agree | un-decided | dis-agree | strongly disagree |
|---|---|---|---|---|---|---|
| 1. | Technology is very important in life. | 1 | 2 | 3 | 4 | 5 |
| 2. | Technology makes everything go better than before. | 1 | 2 | 3 | 4 | 5 |
| 3. | Technology is only concerned with computers. | 1 | 2 | 3 | 4 | 5 |
| 4. | When something new is discovered, I want to know more about it immediately. | 1 | 2 | 3 | 4 | 5 |
| 5. | Working in technology is very creative. | 1 | 2 | 3 | 4 | 5 |
| 6. | Girls cannot do technology. | 1 | 2 | 3 | 4 | 5 |
| 7. | I positively do not want to have a job in technology. | 1 | 2 | 3 | 4 | 5 |
| 8. | Developed countries can do much for developing countries by technology. | 1 | 2 | 3 | 4 | 5 |
| 9. | Technology is good for the economy. | 1 | 2 | 3 | 4 | 5 |
| 10. | I have never used a screwdriver. | 1 | 2 | 3 | 4 | 5 |
| 11. | In everyday life you do not have much to do with technology. | 1 | 2 | 3 | 4 | 5 |
| 12. | In technology you have many opportunities to use your imagination. | 1 | 2 | 3 | 4 | 5 |
| 13. | Technology is too difficult for me. | 1 | 2 | 3 | 4 | 5 |
| 14. | A girl can have a technological profession just as well as a boy. | 1 | 2 | 3 | 4 | 5 |
| 15. | All jobs have something to do with technology. | 1 | 2 | 3 | 4 | 5 |
| 16. | In technology you have to design things by yourself. | 1 | 2 | 3 | 4 | 5 |
| 17. | For pupils of my age technology is **not** interesting. | 1 | 2 | 3 | 4 | 5 |

| | strongly agree | agree | un-decided | dis-agree | strongly disagree |
|---|---|---|---|---|---|
| 18. I know pretty well how an electric toaster works. | 1 | 2 | 3 | 4 | 5 |
| 19. In the newspapers you often read about technology. | 1 | 2 | 3 | 4 | 5 |
| 20. Without technology there would be more problems in the world. | 1 | 2 | 3 | 4 | 5 |
| 21. Boys are able to repair things better than girls. | 1 | 2 | 3 | 4 | 5 |
| 22. You do not have to be creative in technology. | 1 | 2 | 3 | 4 | 5 |
| 23. To understand something of technology you have to take a difficult training course. | 1 | 2 | 3 | 4 | 5 |
| 24. A hundred years ago there was no technology. | 1 | 2 | 3 | 4 | 5 |
| 25. I would like to learn more about technology. | 1 | 2 | 3 | 4 | 5 |
| 26. Developing countries should develop their own technology. | 1 | 2 | 3 | 4 | 5 |
| 27. It is a good thing when girls learn to repair their own bicycles. | 1 | 2 | 3 | 4 | 5 |
| 28. Technology gives people more leisure. | 1 | 2 | 3 | 4 | 5 |
| 29. It is difficult for me to say now whether or not I want to choose a technological profession. | 1 | 2 | 3 | 4 | 5 |
| 30. There should be more TV programs about technology. | 1 | 2 | 3 | 4 | 5 |
| 31. To know how a bike is constructed you do not have to study technology. | 1 | 2 | 3 | 4 | 5 |
| 32. Thoughts of technology are not often in my mind. | 1 | 2 | 3 | 4 | 5 |
| 33. Technology has brought more good things than bad things. | 1 | 2 | 3 | 4 | 5 |
| 34. If you know nothing about technology you are behind the times. | 1 | 2 | 3 | 4 | 5 |

| | | strongly agree | agree | un-decided | dis-agree | strongly disagree |
|---|---|---|---|---|---|---|
| 35. | Girls prefer not to go to a technical school. | 1 | 2 | 3 | 4 | 5 |
| 36. | At school I hear enough about technology to be able to make a choice about going or not going to a technical school. | 1 | 2 | 3 | 4 | 5 |
| 37. | In technology there are not many inventions that are really new. | 1 | 2 | 3 | 4 | 5 |
| 38. | If there was a club about technology at school, I would certainly join it. | 1 | 2 | 3 | 4 | 5 |
| 39. | Technology is good for developing countries. | 1 | 2 | 3 | 4 | 5 |
| 40. | I do not know what the word 'technology' includes. | 1 | 2 | 3 | 4 | 5 |
| 41. | Humans can not do without technology | 1 | 2 | 3 | 4 | 5 |
| 42. | Technology is always bad for the environment. | 1 | 2 | 3 | 4 | 5 |
| 43. | Boys know more about technology than girls do. | 1 | 2 | 3 | 4 | 5 |
| 44. | I would like to work in technology later. | 1 | 2 | 3 | 4 | 5 |
| 45. | Designing an appliance is not a part of technology. | 1 | 2 | 3 | 4 | 5 |
| 46. | I am not interested in technology. | 1 | 2 | 3 | 4 | 5 |
| 47. | At school you do not hear much of technology. | 1 | 2 | 3 | 4 | 5 |
| 48. | With technology you learn to assemble appliances. | 1 | 2 | 3 | 4 | 5 |
| 49. | I think technology is a bit scary. | 1 | 2 | 3 | 4 | 5 |
| 50. | I know how most appliances are constructed. | 1 | 2 | 3 | 4 | 5 |
| 51. | More girls should go to a techical school. | 1 | 2 | 3 | 4 | 5 |
| 52. | Technology make people ask for more and more comfort. | 1 | 2 | 3 | 4 | 5 |

| | strongly agree | agree | un-decided | dis-agree | strongly disagree |
|---|---|---|---|---|---|
| 53. When I choose a profession I do not consider whether or not it is technological. | 1 | 2 | 3 | 4 | 5 |
| 54. I like to read technological magazines. | 1 | 2 | 3 | 4 | 5 |
| 55. Making a dress is a sort of technology. | 1 | 2 | 3 | 4 | 5 |
| 56. Technology is the subject of the future. | 1 | 2 | 3 | 4 | 5 |
| 57. Technology is as difficult for girls as it is for boys. | 1 | 2 | 3 | 4 | 5 |
| 58. I enjoy repairing things at home myself. | 1 | 2 | 3 | 4 | 5 |
| 59. Technology is: working with your hands. | 1 | 2 | 3 | 4 | 5 |
| 60. You must be very clever to be able to study technology. | 1 | 2 | 3 | 4 | 5 |
| 61. A girl had better not become a mechanic. | 1 | 2 | 3 | 4 | 5 |
| 62. Technology always has to do with electricity. | 1 | 2 | 3 | 4 | 5 |
| 63. Modern technology should be adapted before being applied to developing countries. | 1 | 2 | 3 | 4 | 5 |
| 64. At school you should learn more about repairing things around the home. | 1 | 2 | 3 | 4 | 5 |
| 65. You can learn a lot of technology by yourself. | 1 | 2 | 3 | 4 | 5 |
| 66. Mothers should be able to repair domestic appliances themselves. | 1 | 2 | 3 | 4 | 5 |
| 67. At school you never hear anything about technological jobs. | 1 | 2 | 3 | 4 | 5 |
| 68. In technology there is not much opportunity to invent things by yourself. | 1 | 2 | 3 | 4 | 5 |
| 69. It would have been better if no technological inventions had ever been made. | 1 | 2 | 3 | 4 | 5 |
| 70 I know what most appliances are for. | 1 | 2 | 3 | 4 | 5 |

| | strongly agree | agree | un-decided | dis-agree | strongly disagree |
|---|---|---|---|---|---|
| 71. Girls should repair their own bicycle tires. | 1 | 2 | 3 | 4 | 5 |
| 72. Technology makes people more creative. | 1 | 2 | 3 | 4 | 5 |
| 73. I cannot list many technical jobs. | 1 | 2 | 3 | 4 | 5 |
| 74. Technology is only for bright people. | 1 | 2 | 3 | 4 | 5 |
| 75. Technology mostly is not dangerous. | 1 | 2 | 3 | 4 | 5 |
| 76. Sometimes I have taken things apart to see how they work. | 1 | 2 | 3 | 4 | 5 |
| 77. Technology is nothing but applied physics. | 1 | 2 | 3 | 4 | 5 |
| 78. These sorts of questions about technology are difficult for me. | 1 | 2 | 3 | 4 | 5 |

## APPENDIX H: FORM FOR SUGGESTING ACTIVITIES

Name: _____

School: _____

School Address: _____

_____

**Return Form To:**

Commission on Technology Education for
the State of New Jersey
c/o NJ Bell
6000 Hadley Road
South Plainfield, NJ 07080

Activity for MODULE #___ : _____

Module Objective: #____ : _____

Title of Activity: _____

Description of Activity:

Design Brief:

Comments: